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TENTH
ANNUAL REPORT
OF THE
LOWELL WATER BOARD
TO THE CITY COUNCIL,

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF THE
SUPERINTENDENT OF WATER WORKS, TO THE WATER BOARD.

JANUARY 9, 1883.

LOWELL, MASS.:
COURIER PRESS: MARDEN & ROWELL.
1883.

1142
AST
TIL
20-

CITY OF LOWELL.

IN WATER BOARD, January 9, 1883.

Read and accepted, and ordered to be transmitted to the City Council.

Attest.

JAMES M. BATTLES, *Clerk*.

IN COMMON COUNCIL, January 9, 1883.

Read, and sent to the Board of Aldermen.

DAVID CHASE, *Clerk*.

IN BOARD OF ALDERMEN, January 9, 1883.

Received and read.

DAVID W. O'BRIEN, *City Clerk*.

WATER BOARD, 1883.

President ALBERT A. HAGGETT.

Term expires first Monday in May, 1883.

CHARLES C. HUTCHINSON.

Term expires first Monday in May, 1884.

Alderman GEORGE W. FIFIELD.

Councilman EDWARD B. PEIRCE. Councilman JOHN J. HOGAN.

Clerk JAMES M. BATTLES.

Regular meetings of the Water Board, Friday evenings, at 7 1-2 o'clock.

Superintendent of Works HORACE G. HOLDEN.

Foreman of Works DANIEL D. FRASER.

Engineer at Pumping Station JAMES P. ROBERTS.

Service Clerk LEONARD T. FARRIS.

Inspectors.

JOHN J. BANCROFT. ANDREW J. DEVOLL. THOS. G. GERRISH, JR.

Inspectors of Meters.

HENRY E. SPRAGUE.

CHARLES H. HARVEY.

The Water office is open daily, from 9 A. M. to 12 M., and 2 to 5 P. M., and on Monday evenings, from 7 to 8 o'clock.

REPORT OF THE WATER BOARD.

OFFICE OF THE LOWELL WATER BOARD,
LOWELL, MASS., January 9, 1883.

To the City Council of the City of Lowell:

GENTLEMEN — The Lowell Water Board take pleasure in presenting this, the Tenth Annual Report of the Board, and in being able to congratulate our citizens and the City Council upon the continuance of the successful working of our water supply system, both as regards the unlimited supply of pure and wholesome water furnished, and the gratifying financial record of the works committed to our care.

For the kind co-operation of the City Council in granting the needed appropriations for the year, by which the calls for numerous extensions of pipe and other necessary expenditures have been met, we desire to extend our thanks, and would bespeak the same wise and hearty support in all matters which may be deemed necessary and proper for the continued prosperity of our successful system of water works, from the City Council of 1883.

The first meeting of the Board for the year 1882 was held on the evening of the 9th of January, the Board being then composed of the following members: Albert A. Haggett, President, and James W. Bennett,

ered on cars in this city. May 26th bids were received and opened for 800 tons of Powelton mine coal, to be delivered and stored within the coal house at the pumping station; and the contract for the same was awarded to the lowest bidders, Whithed & Co., of this city, at \$6.01 per ton of 2240 lbs.

HIGH SERVICE WORKS.

The works for the High Service Supply were fully completed June 1st, at which date William H. Ward, the contractor for the construction of the High Service Reservoir, completed his contract for said Reservoir, to the complete satisfaction of the City Engineer and the Board. We here desire to express our thanks to Mr. Ward for the faithfulness and energy which he displayed in the successful and workmanlike manner in which this important part of our High Service System was constructed by him, and for the gentlemanly and courteous manner which he exhibited in all his dealings with the Board in connection therewith.

January 9th, the City Engineer deeming it advisable that a bank wall be constructed on the westerly side of the Reservoir lot for the reception of the fence on that side of the lot, a contract was made with Mr. Ward for the construction of said wall at a cost of \$1,174.25, which contract was faithfully and satisfactorily completed.

May 12th proposals were issued for the construction of a suitable fence around the High Service Reservoir lot, and on May 19th bids for its construction were received from eight different parties, ranging from \$650, the highest, to \$520, the lowest, the latter sum being

from F. A. Parker, to whom the contract was awarded. Mr. Parker satisfactorily completed his contract, and the Reservoir lot is surrounded by a neat and substantial fence.

The amount appropriated for the construction of the High Service System was \$75,000—the *actual cost* of the same has been \$68,867.98, or \$6,132.02 less than the amount appropriated; a fact, in these days of liability to *exceed* appropriations, especially upon City work, worthy of record. We congratulate our citizens and the City Council upon the possession of a system of water supply for all sections of our municipality second to none within our knowledge, and trust that the same wise care and prudent management which have been bestowed upon it in the past, may continue so long as Lowell may require works which are such a blessing to our community.

The revenue derived from the High Service System during the past year is shown by the following table:—

BELVIDERE SECTION—containing 37 houses and 38 families, (2 new houses which are vacant and 1 house where the water is “not on” are included in the number of houses, but not included in the income)		\$530.50
CENTRALVILLE SECTION—containing 64 houses and 70 fami- lies (4 new houses which are vacant and 1 house where the water is “not on” are included in the num- ber of houses, but not included in the income)		673.50
Hydrant Services in both sections		500.00
Total Revenue for the year		<u>\$1,704.00</u>

INSPECTION OF FIXTURES.

Oct. 4th, the inspectors were ordered to make a careful examination and record of all water fixtures in premises of water takers, where metered water is not in use, for the purpose of ascertaining what fixtures, if any, had not been rendered to them at the annual taking in March. This inspection, which is not yet completed, has shown that large numbers of fixtures of all kinds have been added, and either through failure of the owner, or the plumber who put them, in to report the same to the inspectors at the annual visit in March, or to the Water Board office, when added, the City has failed to be the recipient of the water rates justly due from such additions. Much of the loss thus experienced we think might be obviated by the passage of an ordinance by the City Council, requiring all plumbers and pipe-fitters to be licensed by the Water Board, with such restrictions contained in said license as will secure proper returns to be made to the Water Board of the class of work proposed to be done by said plumbers or pipe-fitters in connection with the Water Works of the City. Such licenses to be granted to practical plumbers only, who have had good experience in their business. We think that much inconvenience and damage resulting from poor and inefficient workmanship could thus be avoided, and consequent waste of water be prevented. Many cities have such an ordinance, and the results therefrom are found to be valuable in preventing leaks and waste caused by bad workmanship, as well as in the certainty of having a record of all the fixtures in use in connection with the Works, before such fixtures have been placed within

the premises of the water-takers. We respectfully refer this subject to our successors upon the Water Board, and to the City Council of 1883.

STATISTICS.

The total amount of water pumped into the reservoir for the year was 959,931,730 U. S. gallons, against 874,996,660 U. S. gallons in the year 1881; and the daily average pumped was 2,629,950 gallons, against 2,521,604 gallons in 1881; an increase for the year of 84,935,070 gallons, and of 108,346 gallons in the daily average. The quantity of coal consumed during the year, for all purposes, excepting for High Service Supply, was $914\frac{2}{3}$ tons, against $817\frac{1}{2}$ tons in 1881. For the High Service Supply there were consumed $19\frac{1}{2}$ tons. There have been 525 $\frac{1}{8}$ gallons of water raised 166 feet high for each pound of coal consumed during the year. The total number of water takers is 13,000, against 12,600 in 1881, a gain for the year of 400. There are now laid $70\frac{5}{8}$ miles of street mains — the increase for the year having been $2\frac{4}{8}$ miles. The total net charges for water-rates for the year, after deducting all abatements, and the charges for service-pipes have been \$131,580, against \$122,867.22 for the year 1881 — an increase for the year of \$8,712.78.

The following table will show the charges for water, by months, from the commencement of the works to December 31, 1882, with all abatements, and total net charges:—

CHARGES FOR WATER BY MONTHS, FROM COMMENCEMENT TO DECEMBER 31, 1882.

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
January . . . . .	. . . .	\$ 363 94	\$ 418 6	\$ 150 45	\$126 51	\$ 169 13	\$ 282 44	\$ 233 73	\$ 182 58	\$ 233 37
February . . . . .	. . . .	35 33	235 43	238 25	86 84	144 38	238 19	349 08	146 40	139 22
March	\$ 6,124 94	50,200 10	65,417 68	82,249 51	80,177 52	82,225 43	80,603 65	80,567 44	89,210 88	90,856 37
April	785 89	1,739 56	935 20	265 34	584 11	1,970 12	9,242 84	6,478 39	540 20	403 64
May	3,988 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61	1,191 41
June	5,818 78	2,865 86	2,987 43	4,460 91	2,389 52	3,903 69	6,126 40	868 08	12,574 25	16,401 62
July	4,833 52	1,889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	873 00	959 80
August	2,728 30	498 50	449 86	771 87	799 88	677 01	563 35	459 17	514 46	634 40
September	2,827 07	3,245 06	865 90	495 97	3,493 90	4,998 07	6,584 86	8,108 23	10,088 19	10,904 30
October	9,729 05	872 10	2,947 93	4,893 44	543 79	663 80	454 29	338 51	399 22	552 27
November	761 21	634 03	573 35	1,445 65	518 72	1,220 27	1,405 89	620 56	973 16	378 97
December	1,571 72	3,689 79	3,955 59	3,246 39	4,040 71	4,522 75	5,794 77	7,851 52	9,593 32	10,848 08
Totals	\$39,168 64	\$69,307 39	\$82,861 60	\$99,674 93	\$98,178 93	\$102,877 32	\$115,261 20	\$118,808 70	\$125,975 27	\$133,503 45
Less abatements to date . . . .	. . . .	1,872 83	640 06	8,185 88	2,502 65	4,343 13	6,590 05	1,702 13	3,766 88	1,923 45
Net amounts	\$39,168 64	\$67,434 56	\$82,221 54	\$91,489 05	\$95,676 28	\$98,534 19	\$105,671 15	\$117,106 57	\$122,208 39	\$131,580 00

<i>Amounts brought forward</i>	\$16,578 50	2,289,801 01
Gate boxes, &c.	115 50	
Service boxes	62 49	
	<u>\$16,756 49</u>	

Labor, pay-roll on acct. of—

Extensions	\$3,208 84	
Services	1,834 36	
Piping	644 62	
Teaming	563 75	
	<u>\$6,251 57</u>	

Total ordinary construction . . . \$23,008 06

HIGH SERVICE SUPPLY:—

Cast-iron pipe	\$900 00
Wrought-iron pipe and supplies	10 59
Check valve	175 00
Gates and hydrants	166 10
W. H. Ward, balance on Reser-	
voir contract	5,300 37
“ for bank wall	1,174 25
Fence, Reservoir lot, grading, &c.	643 90
Rubble for Reservoir	36 00
Worthington engine	1,800 00
Freight on same, bolts, &c.	36 70
	<u>\$10,242 91</u>

Labor, pay-roll on acct. of—

Reservoir	\$343 94
Engineering	202 49
Extensions	109 25
	<u>\$655 68</u>

Total High Service construction . . \$10,898 59

Total construction account . . . \$33,906 65

Amount brought forward \$2,289,801 01

MAINTENANCE.

EXPENDED FOR REPAIRS, CURRENT EXPENSES,

PUMPING, &c., viz. :—

Repairs.

Labor, pay-roll	\$2,325 53
Wrought-iron pipe and fittings	1,210 11
Shed at pipe yard	111 89
Service covers and concrete	195 87
Engineer's house, windows and blinds	70 44
Repairing drains and gate chambers	121 67
Packing hydrants	74 50
Hardware	183 96
Lime, sand, cement and brick	115 60
Lumber	109 90
Supplies	107 07
Lead pipe and hose	89 00
Fuel	12 88

Total repairs \$4,728 42

CURRENT EXPENSES. Pay-roll.

Salaries	\$3,075 00
Inspection	2,479 10
Foreman	927 00
Clerk hire	877 45
City Engineer	272 36
	<u>\$7,630 91</u>

Materials.

Printing, stationery, &c.	\$544 83
Horse keeping, &c.	283 44
Repairs of wagon, harnesses, &c.	377 65
Telephone	184 59
Flushing sewers	116 00
Supplies	118 41
Damages	68 00
Filter gallery, washing, &c.	53 22
	<u>\$1,746 14</u>

Total current expenses \$9,377 05

Amount carried forward \$2,289,081 01

Amount brought forward \$2,289,081 01

PUMPING ACCOUNT. Materials.

Coal	\$4,584 12	
Labor, pay-roll	3,172 69	
New boiler	925 46	
Morris engine, plungers	219 65	
Oil and tallow	136 50	
Waste and packing	81 57	
Gas	25 94	
Hardware	15 99	
Other supplies	45 15	
	<hr/>	
Total pumping account		<u>\$9,207 07</u>

RESERVOIR.

Labor, pay-roll	\$547 50	
Supplies, teaming, &c.	47 35	
	<hr/>	
Total reservoir account		<u>\$594 85</u>

METER ACCOUNT.

Meters purchased	\$4,205 04	
Labor, pay-roll	2,069 30	
Repairs on meters	90 48	
Teaming	251 64	
Freight paid on meters	44 91	
Supplies	50 51	
	<hr/>	
Total meter account		<u>\$2,506 84</u>

RECAPITULATION.

Total construction account	\$33,906 65	
Repairs	\$4,728 42	
Current expenses	9,377 05	
Pumping account	9,207 07	
Reservoir account	594 85	
Meter account	2,506 84	
	<hr/>	
Total maintenance account	\$26,414 23	
Meters bought	4,205 04	
	<hr/>	
<i>Amounts carried forward</i>	\$64,525 92	<u>2,289,801 01</u>

<i>Amounts brought forward</i>	\$64,525 92	2,289,801 01
Amount expended for the year, exclusive of interest	\$64,525 92	
Interest paid during the year	109,120 00	
Total expenditure for the year		\$173,645 92
		<u>\$2,463,446 93</u>

CREDITS.

Amounts received by City Treasurer during the
year for water rates, service pipe and sun-
dries, as follows :

For account of 1877	\$ 3 00	
" 1880	1 93	
" 1881	12,018 32	
" 1882	128,307 87	
For fees	30 00	
sundries	36 84	
Total receipts for the year		140,397 96
Net cost of Works, including interest on Water Loan to January 1, 1883		<u>\$2,323,048 97</u>
Present debt of the city, by bonds and notes, on ac- count of the construction of the Water Works		<u>\$1,875,000 00</u>
Total amount paid from City Treasury to January 1, 1883, by taxation, on account of Water Works, in excess of receipts from loans and of water rates		\$448,048 97
Value of Water Works Sinking Funds, Jan. 1, 1883		356,459 52
		<u>\$804,508 49</u>
Net cost of Works, including interest on Water Loans, to January 1, 1883		\$2,323,048 97
Whole amount paid by taxation, and by appropriation for the Sinking Funds, and the value of the accumu- lation of said Funds, January 1, 1883		804,508 49
Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, January 1, 1883		<u>\$1,518,540 48</u>

The following table will show the gross cost of the Water Works, yearly, from the commencement of the same to Jan. 1, 1883 :

Expended in 1870	.	.	.	.	\$ 95,057 00
“ 1871	.	.	.	.	624,151 66
“ 1872	.	.	.	.	560,708 40
“ 1873	.	.	.	.	349,717 87
“ 1874	.	.	.	.	233,370 63
“ 1875	.	.	.	.	275,660 78
“ 1876	.	.	.	.	221,502 24
“ 1877	.	.	.	.	163,814 28
“ 1878	.	.	.	.	158,510 15
“ 1879	.	.	.	.	150,047 82
“ 1880	.	.	.	.	154,391 59
“ 1881	.	.	.	.	231,171 27
“ 1882	.	.	.	.	173,645 92
					<hr/>
Gross cost of Works to Jan. 1, 1883,					\$3,391,749 61
Receipts from various sources to Jan. 1, 1883					1,068,700 64
					<hr/>
Net cost of Works to Jan. 1, 1883	.				<u>\$2,323,048 97</u>

All portions of the works are in excellent condition, as will be seen by reference to the Annual Report of the Superintendent, accompanying this Report, and no changes or additions thereto will be required during the coming year, so far as we can foresee, other than the extensions of street-mains which may be called for in new territory not now built upon.

In closing this Report we are gratified to note the general efficiency of all, from the Superintendent of the Works to the lowest subordinate employed in this department, and we cheerfully recommend them all to our successors for their faithfulness in the discharge of the many duties which devolve upon them in the prosecution of the work allotted them to do. That the City may have the continued service of these faithful

employees in this important department of her affairs, is our earnest desire.

Appended herewith will be found the Reports of the City Engineer and Superintendent of the Works, in each of which will be found many interesting statistics, worthy of more than a passing glance. We also present the balance sheet of the City Treasurer, showing the charges and receipts for water-rates, service pipe and sundries, for the year ending Dec. 31, 1882.

Respectfully submitted.

A. A. HAGGETT,
CHAS. C. HUTCHINSON,
THOMAS R. GARITY,
WILLIAM N. OSGOOD,
FRANK WOOD,

Lowell Water Board.

ACCOUNTS OF THE TREASURER.

WATER RATES, SERVICE PIPE

Dr. JOHN H. McALVIN, *City Treasurer and Collector*

For amount of charges previously reported . . \$104,018 47

\$104,018 47

WATER RATES, &c.,

For amount of charges previously reported . . \$109,172 89

\$109,172 89

WATER RATES, &c.,

For amount of charges previously reported . . \$123,879 68

\$123,879 68

WATER RATES, &c.,

For amount of charges previously reported . . \$124,837 00

\$124,837 00

WATER RATES, &c.,

For amounts previously reported \$133,648 87

January, 1882, charges 808 55

February " " 762 32

\$135,219 74

AND SUNDRIES, 1877 ACCOUNT.

of Taxes of the City of Lowell.

CR.

By amount of collections previously reported . . .	\$101,231 41
Abatements made to December 31, 1882 . . .	2,787 06
	<u>\$104,018 47</u>

1878 ACCOUNT.

By amount of collections previously reported . . .	\$104,801 04
Abatements made to December 31, 1882 . . .	4,371 85
	<u>\$109,172 89</u>

1879 ACCOUNT.

By amount of collections previously reported . . .	\$114,114 27
Abatements made to December 31, 1882 . . .	9,765 41
	<u>\$123,879 68</u>

1880 ACCOUNT.

By amount of collections previously reported . . .	\$122,795 54
Collections made in 1882	4 93
Abatements made to December 31, 1882	1,970 24
Abatements withdrawn	6 00
Transferred to account of 1882	60 29
	<u>\$124,837 00</u>

1881 ACCOUNT.

By amount of collections previously reported . . .	\$119,143 63
Collections in January, 1882	5,383 52
" in February, "	5,820 78
" in March, "	723 90
" in April, "	71 22
" in May, "	15 90
Transferred to 1882 account	183 64
" " "	345 74
" " "	217 10
Abatements made up to December 31, 1882 . . .	3,314 31
	<u>\$135,219 74</u>

TENTH ANNUAL REPORT
OF THE
CITY ENGINEER TO THE WATER BOARD.

January 9, 1883.

REPORT OF THE ENGINEER.

OFFICE OF CITY ENGINEER,
LOWELL, MASS., Jan. 1, 1883.

To the Lowell Water Board :

GENTLEMEN—The following is the Tenth Annual Report of the work done by the pumping-engines at the Lowell Water Works Pumping-Station, calculated from the records kept by Mr. James P. Roberts, the Engineer in charge. In the calculations of the “duty” of the engines nothing has been allowed for friction of water in the pumps, etc.

No “duty” has been calculated for the high-service engine. During eight days in May the high-service engine pumped directly into the distribution pipes, and performed the work very easily. It takes the water from the Beacon-street reservoir, and has a back pressure of sixty pounds. It will be seen by the following table that it has only been necessary to pump fifty-four days, or five hundred and sixty-three hours, to supply the high-service districts, which proves the engine to have sufficient capacity for many years, unless more of the low-service territory is changed to the high-service. Since January 1st, 1873, the Morris engine has pumped twenty-three hundred and eighty-four days of ten hours each, and since February 1st, 1876, the Worthington engine (low-service) has pumped two hundred and seventy days.

Table showing work done with Morris Engine (Beam and Fly-Wheel) and Boilers, for each month during the year 1882.

MONTHS.	No. of days' pumping.	Av'e No. of hours' pumping per day.	No. of hours' pumping per month.	No. of strokes made per month.	Av'e No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Ave. pressure.
January . . .	30	11-52	355-55	247,983	11.61	166.56	79,354,560	
February . . .	28	12-03	337-15	243,212	12.00	165.28	77,827,840	
March . . .	20	11-15	326-20	234,959	11.49	165.14	71,986,860	
April . . .	20	11-27	228-55	158,284	11.52	165.16	50,650,880	
May . . .	25	11-18	282-25	195,408	11.53	165.26	62,530,560	
June . . .	27	11-51	320-00	220,647	11.49	166.85	70,575,040	
July . . .	1	9-40	9-40	6,422	11.07	171.75	2,055,040	
August . . .	24	11-41	280-40	193,235	11.47	165.81	61,835,200	
September . .	30	11-46	353-10	249,025	11.75	165.56	79,088,000	
October . . .	26	11-47	306-30	211,890	11.52	165.84	67,807,680	
November . . .	26	11-30	303-00	210,003	11.55	165.17	67,200,960	91,123.05
December . . .	30	12-06	364-15	256,991	11.76	166.46	82,237,120	91,700.43
Totals and ave'g's	296	11-32	3,468-25	2,417,968	11.13	166.32	773,749,760	91,097.78

Table showing work done with Worthington Duplex Engine and Boilers at Pumping Station, for each month during the year 1882.

Table showing amount of coal, etc., used for Morris Engine at Pumping Station, for each month during the year 1882.

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal consumed.
January . .	18,000	119,000	6,200	143,200
February . .	16,800	117,700	5,600	140,100
March . . .	17,400	109,750	6,200	133,350
April . . .	12,000	77,350	6,000	95,350
May	15,000	95,280	6,000	116,280
June	16,200	108,450	6,000	130,650
July	600	3,000	2,800	6,400
August . . .	8,400	96,940	2,800	108,140
September .	17,400	119,970	5,800	143,170
October . . .	15,600	103,410	5,800	124,810
November . .	15,600	102,130	6,000	123,730
December . .	18,000	124,330	6,200	148,530
Totals . . .	171,000	1,177,310	65,400	1,413,710

Table showing amount of coal, etc., used for the Worthington Duplex Engine, at Pumping Station, for each month during the year 1882.

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal consumed.
January . .	2,700	21,480	1,000	25,180
February . .				
March . . .				
April	3,000	23,740	1,290	28,030
May	1,800	14,300	600	16,700
June	3,900	23,720	1,200	28,820
July	24,000	182,030	5,600	211,630
August	9,900	73,600	2,200	85,700
September . .				
October	1,800	15,900	600	18,300
November . . .				
December . . .				
Totals	47,100	354,770	12,490	414,360

Table showing work done with Worthington High-Service Engine, at Pumping Station, 1882.

MONTHS.	No. of days' pump- ing.	Average No. of hours' pumping per day.	No. of hours' pumping per month.	No. of strokes made per month.	Average No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month in U. S. gallons.	Average quan- tity pumped per day in U. S. gallons.	No. of galls. of water pumped into reservoir per lb. of coal, for total coal consumed.	Coal in pounds used when pumping.
January . .	3	4-20	13-00	31,009	39.76	62.79	434,126	144,708	204	2,130
February . .	4	3-52	15-30	28,875	31.05	64.51	404,250	101,062	155	2,600
March . . .	3	3-40	11-00	19,850	30.07	64.51	277,900	92,633	154	1,800
April . . .	3	6-00	18-00	30,078	27.85	64.51	421,092	140,364	186	2,260
May . . .	10	19-54	199-00	73,744	6.17	70.53	1,032,416	57,356	211	4,892
June . . .	6	9-21	56-05	109,555	32.55	70.85	1,533,770	255,628	337	4,550
July . . .	5	8-43	41-05	87,787	35.61	77.19	1,229,018	245,803	341	3,600
August . .	7	10-21	72-25	154,577	35.57	73.73	2,164,078	270,509	316	6,850
September .	3	10-40	32-00	70,625	36.78	78.34	988,750	329,583	342	2,890
October . .	3	10-45	32-15	62,877	32.49	77.65	880,278	293,426	423	2,080
November .	3	10-06	30-20	64,866	35.64	76.79	908,124	302,708	324	2,800
December .	4	10-37	42-30	87,250	34.21	78.91	1,221,500	305,375	355	3,440
Tot's and av'gs	54	10-26	563-10	821,093	24.30	71.69	11,495,302	182,465	288	39,892

PUMPING-STATION, MORRIS ENGINE.

Running Expenses for the Year 1882.

Pay of engineer and firemen	\$2,568 00
4 $\frac{1}{2}$ $\frac{8}{10}$ tons coal (George's Creek), at \$6.384	28 91
423 $\frac{6}{10}$ $\frac{3}{10}$ tons coal (Powelton), '81, at \$5.134	2,173 30
279 $\frac{2}{10}$ $\frac{2}{10}$ tons coal (Powelton), at \$5.37	1,498 28
Wood	5 25
Gas for lighting works	21 73
55 gallons cylinder oil, at .75	41 25
49 gallons engine oil, at .45	22 05
1 gallon lard oil	1 20
674 lbs. tallow, at .09	60 66
34 $\frac{1}{4}$ lbs. soapstone packing, at .30	10 28
3 $\frac{1}{8}$ lbs. Asbestos packing, at .50	1 69
29 $\frac{1}{4}$ lbs. hemp packing	9 61
75 lbs. cotton waste, at .12 $\frac{1}{2}$	9 37
Repairs on engine and pump	230 15
Repairs on boilers	46 42
Sundries	30 25
Total	<u>\$6,758 40</u>

Cost of raising water into reservoir, per million gallons, \$8 73

Cost of raising water, per million gallons, one foot high, .05 $\frac{2}{10}$

WORTHINGTON ENGINE.

Running Expenses for the Year 1882.

Pay of engineer and firemen	\$567 00
190 $\frac{1}{2}$ $\frac{3}{10}$ $\frac{7}{10}$ tons coal (Powelton), '81, at \$5.134	978 97
7 $\frac{6}{10}$ $\frac{9}{10}$ tons coal, at \$6.116	44 92
9 $\frac{3}{10}$ $\frac{0}{10}$ tons coal (Powelton), at \$5.37	49 13
Wood	3 50
Gas for lighting works	4 80
28 gallons cylinder oil, at .75	21 00
10 lbs. soapstone packing, at .30	3 00
Amonnt carried forward	<u>\$1,672 32</u>

<i>Amount brought forward</i>	\$1,672 32
42 lbs. cotton waste, at .12½	5 25
Repairs on engine	1 50
Repairs on boilers	10 89
Sundries	7 09
Total	\$1,697 05

Cost of raising water into reservoir, per million gallons,	\$9 12
Cost of raising water, per million gallons, one foot high,	.05 ⁵ / ₁₀ ⁵ / ₁₀

RESERVOIR, 1882.

The following table shows the average depth of water, the number of gallons, and the temperature of the water in the reservoir, and also the temperature of the air, for each month. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 P. M., and 6 P. M.

MONTHS.	Depth in feet.	Quantity in U. S. gallons.	Temperature in degrees.	
			Of water.	Of air.
January	18.49	28,049,700	35.4	22.5
February	18.98	28,855,700	35.1	28.1
March	19.73	30,129,100	35.9	33.7
April	19.50	29,733,700	43.3	42.6
May	19.50	29,733,700	50.8	50.7
June	19.02	28,926,700	62.7	68.9
July	19.48	29,698,700	70.6	75.0
August	19.30	29,405,000	74.5	72.1
September	19.17	29,174,700	65.9	63.9
October	19.09	29,040,900	58.1	53.6
November	19.97	30,531,300	47.3	35.6
December	19.90	30,417,200	33.5	35.8

The following table shows the average monthly and daily consumption of water for the year 1882.

MONTHS.	Gallons per month.	Gallons per day.
January	89,390,420	2,883,560
February	78,667,110	2,809,540
March	70,162,040	2,263,290
April	64,919,680	2,163,990
May	68,310,840	2,203,580
June	82,226,510	2,774,220
July	99,139,730	3,220,640
August	99,840,930	3,220,680
September	79,547,630	2,651,590
October	75,467,480	2,434,430
November	66,354,070	2,211,800
December	81,528,020	2,629,940
Total and average	957,254,460	2,622,615

HIGH-SERVICE SUPPLY.

During last winter a substantial bank wall was laid on portions of the west side of the reservoir lot on Mt. Pleasant street, and the north side adjoining the city gravel lot. April 10th work was resumed on the reservoir slope, paving and concreting at top of slope. May 22d the water was drawn from the reservoir, and the puddle on the bottom was finished, and all surplus material removed. About noon on the 25th of May, water was again let in, and the reservoir was allowed to fill. The sodding and grading of the outside slope were finished May 31st, thus completing Mr. Ward's

contract, which has been done in a faithful and satisfactory manner.

The grounds were subsequently graded and a fence built around the lot, under the direction of the Superintendent of the Water Works. Although some important changes were made in the location of the distributing main, it is gratifying to state that the high-service water supply has cost \$2,830 less than the original estimate (\$71,700).

Respectfully submitted.

GEO. E. EVANS, *City Engineer.*

TENTH ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS,
TO THE
LOWELL WATER BOARD.

January 1, 1883.

REPORT OF THE SUPERINTENDENT.

SUPERINTENDENT'S OFFICE, CITY HALL,
LOWELL, January 1, 1883.

To the Lowell Water Board:

GENTLEMEN — In compliance with the city ordinance I respectfully submit herewith the tenth annual report of the Superintendent of the Lowell Water Works for the year ending December 31, 1882.

The Works and everything connected with them are in good condition, and during the past year there has been no freezing of mains or service-pipes, and but few leaks of any account.

The total amount of water pumped is 959,931,730 gallons. The amount of water sold by meter is 229,000,000 gallons. The average amount of water used per day for each inhabitant is 40.44 gallons. This includes all the water used for street drinking fountains, manufacturing purposes, extinguishing fires, &c.

FILTER-GALLERY AND CONDUIT.

At an examination of the filter-gallery and conduit, December 26th, the mason-work was all in good condition, and the amount of sediment in the conduit does not appear to have increased any in depth for the past four years. The spongy formation is gradually increasing on the bottom and sides of the gallery, and

HIGH SERVICE.

During the year 114,953,020 gallons of water have been pumped into the high-service reservoir. Owing to a delay in getting material the reservoir was not completed until June 1st. Previous to that time about four feet of water was all that could be kept in the reservoir, but on completion water was pumped in to a depth of 16 feet, and from 12 feet to 16 feet of water has been kept in ever since. There has yet been no settling of the banks, and to all appearances the reservoir is now perfectly tight. After the reservoir was completed the grounds around it were graded, the stones and rocks all cleared off, about twelve inches of loam spread on, and the whole sowed with grass. A bank wall averaging four feet in height has been built on a portion of the east and north sides, also the whole length of the west side on Mt. Pleasant street, and the whole grounds have been surrounded by a picket fence 7½ feet high. The high-service mains have been extended in Belvidere on Fairmount street, from the end of the pipe to the Tewksbury line; on Fairview street to D. C. Brown's house, and on Mansur street to the house of T. G. Tweed. In Centralville the high service mains have been extended on Beacon street from Tenth street to Eleventh street, and on Eleventh street to the house of Thomas Walsh. Connections have also been made on Vernon street through Sixth street to Fremont street, so that now the whole of Fremont street is on the high service. In Belvidere there are 37 houses and one fountain, and in Centralville there are 64 houses, one fountain and 3 stables now supplied with water from the high service system.

drant on Western avenue. The Pattee & Perkins hydrant on Chelmsford street near Gates's Tannery, and the Pattee & Perkins hydrant on Grand street near Middlesex street have been taken out and replaced by post hydrants made by the Boston Machine Co. The Chapman Valve Co.'s post hydrant on Merrimack street at the head of Central street has been taken out and replaced by a flush hydrant.

FIRE SERVICES.

Fire services of 4-inch pipe have been put into J. M. Pevey's mill on West Adams street, the Coburn Shuttle Co's mill on Lincoln street, C. I. Hood & Co.'s factory, off Thorndike street, Central Block on Central street and the new post office building on Merrimack street. A 4-inch pipe has been laid for the U. S. Bunting Co.'s mill off Crosby street, which connects on to 2 hydrants and a fire service which are sealed. A 6-inch pipe has also been laid from Hall street, at Coolidge street, into the yard of the Lawrence Manufacturing Co., and besides supplying water by meter is connected to 2 hydrants, which are sealed.

A 12-inch gate has been connected on to the 20-inch main on French street, and also a gate of the same size on Amory street for sprinklers in the Boott cotton house, and the 6-inch gate on the same line on French street has been taken out and replaced by a 12-inch gate for sprinklers for the Merrimack Manufacturing Co.'s cotton house.

At Otis Allen & Son's mill on Mt. Vernon street, two 2-inch pipes have been connected on to the 2-inch

SCHEDULE OF SMALL PIPE LAID.

STREETS.	LENGTH IN FEET.			
	$\frac{3}{4}$ inch.	1 inch.	$1\frac{1}{2}$ inch.	2 inch.
Appleton	120	. . . .
Bassett	123	. . . .
Chestnut	174	. . . .
Decatur Alley	126	. . . .	. . . .
Dutton	67	. . . .	. . . .
Gold	18	242	. . . .
Hampshire	56	. . . .	. . . .
Harrison Ave.	130	. . . .
Howland Court	214	. . . .
Kimball's Court	16	. . . .	. . . .
Kittredge's Court	298	. . . .
Lombard	247	. . . .
Linden Court	125	. . . .	. . . .
North Franklin Court	123
Old Colony	88	. . . .
West	96	. . . .
West Third	31	. . . .	. . . .	. . . .
Worthen	34	. . . .	. . . .	. . . .
Totals	65	408	1732	123
Total amount 2,328 feet.				

METERS.

There are now 1079 meters in use, of which 193 were put in during the past year.

The repairs of meters have been as follows: 46 Worthington meters have been taken out and, after being tarred by the process described in the report of 1880, have been reset; 26 Worthington meters, 22 Desper meters and 15 Ball & Fitts meters have been taken out for repairs and then reset; 6 Worthingtons

and 3 Despers have been destroyed by freezing and 17 Fitts rotary meters have been worn out and replaced by other kinds. The monthly inspection of meters, which was commenced last year, has proved successful, by giving us more accurate registration, keeping the meters in better repair and guarding unnecessary waste and leaks.

The kinds and sizes of meters are shown by the following:

TABLE OF METERS IN USE DEC. 31, 1882.

KINDS.	$\frac{1}{8}$ in.	$\frac{3}{8}$ in.	1 in.	$1\frac{1}{2}$ in.	2 in.	3 in.	4 in.		Totals.
H. R. Worthington, N. Y.	329	27	49	25	16	3	2	.	451
W. E. Desper & Co., Worcester,	343	91	48	1	.	.	.	.	483
Ball & Fitts, Worcester .	44	21	1	1	.	.	.	.	67
Fitts Rotary, Worcester, .	57	13	3	.	.	.	.	.	73
Crown, N. Y.,	1	1	1	.	.	.	.	.	3
Motor Register, . . . . .	.	.	.	.	.	.	.	2	2
Totals,	774	153	102	27	16	3	2	2	1079

SERVICES.

During the year the water has been shut off from the premises of 27 water-takers, for non-payment of water rates; and the number let on upon payment of the rates is 22.

The whole number of services remaining shut off for non-payment is 8.

There have been laid during the year 405 services, making the whole number laid to date 6283.

The amount of service pipe laid is as follows:

Laid during 1882, $\frac{3}{4}$ -inch	.	.	.	.	.	9,976 feet.
" " " 1-inch	.	.	.	.	.	2,495 "
" " " $1\frac{1}{2}$ -inch	.	.	.	.	.	1,097 "
" " " 2-inch	.	.	.	.	.	110 "
						<hr/>
Total laid during 1882	.	.	.	.	.	13,678 feet.
Add amount previously laid	.	.	.	.	.	233,345 "
						<hr/>
Total amount laid	.	.	.	.	.	247,023 "

WATER-TAKERS.

The whole number of water-takers (which includes each family, shop, store, office, and any other such place where city water is used) is estimated to be 13,000.

The number of abatements made during the year is 559, to wit:

ON ACCOUNT OF	1878	1879	1880	1881	1882	Total.
Water . .	\$9 00	\$18 00	\$49 43	\$658 83	\$1,923 45	\$2,658 71
Pipe, etc. .	. . .	. . .	. . .	. . .	57 16	57 16
Totals . .	\$9 00	\$18 00	\$49 43	\$658 83	\$1,980 61	\$2,715 87

Respectfully submitted,

HORACE G. HOLDEN,
Superintendent.

SCHEDULE No. 1.—Low Service.

WATER PIPES LAID IN 1882.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.			
		8 inch.	6 inch.	4 inch.	Total.
Agawam . . .	Extended southerly		67		67
Andrews . . .	Extended northerly		133		133
Beach	Extended northerly		158½		158½
Beach	Extended northerly		48		48
Belmont . . .	From Pine northerly		532		532
Bridge	Extended northerly		650½		650½
Brooks	Extended easterly			102	102
Bowers. . . .	Fletcher and Salem		283		283
Columbus Ave..	Extended easterly		135		135
Court	From Manchester southerly		209		209
Chambers . . .	Extended westerly		200		200
Chelmsford . .	Extended southerly	382			382
Edson	Westford and Princeton		375		375
East Merrimack	Extended easterly		525		525
First	Extended easterly		158		158
Fulton	From West southerly		94½		94½
Grand	Extended southerly			60	60
Hastings . . .	Pine and Liberty		530		530
Harrison Ave..	From Bridge westerly			226½	226½
Kinsman . . .	From Crosby southerly		235		235
L	Jewett and Coburn			197	197
Moore	From Bleachery westerly			278½	278½
Manchester . .	Extended westerly		297		297
Main	From Lincoln northerly		225		225
Methuen . . .	Extended easterly		161		161
Mason	Powell and School		308		308
Otis.	From Moore northerly			258	258
Otis	Extended northerly			168	168
<i>Amounts carried forward</i>		382	5384½	1290	7056½

SCHEDULE NO. 1.—LOW SERVICE.—Concluded.

WATER PIPES LAID IN 1882.

SCHEDULE No. 2.—High Service.

WATER PIPES LAID IN 1882.

SCHEDULE No. 3.—High and Low Service.

SUMMARY OF WATER PIPES LAID.

8
ch.

104

112

SCHEDULE No. 4.—Low Service.

LIST OF HYDRANTS SET IN 1882.

STREETS.	LOCATION.
Beach . .	P East side, 352 feet north from Third Street.
Bowers . .	P South side, 117½ feet east from Fletcher Street.
Bridge . .	P East side, opposite Flint's house.
Belmont . .	P East side, 480 feet north from Pine Street.
Columbus Ave.	P North side, 382½ feet east from Wilder Street.
Court . .	P East side, 219 feet south from Manchester Street.
Chelmsford . .	P West side, 1935 feet south from Forrest Street.
Edson . .	P West side, 356 feet north from Westford Street.
East Merrimack	P South side, 17 feet west from east line of Stackpole Street.
Fulton . .	P West side, 46½ feet south from West Street.
Harrison Ave.	P North side, 188 feet west from Bridge street.
Pine Hill . .	P West side, 101½ feet north from Chambers Street,
Stevens . .	P West side, 1084½ feet south from Pine Street.
School . .	P West side, 92 feet north from Mason Street.
Shaw . .	P North side, 37½ feet east from west line of Sagamore Street.
Stevens . .	P West side, 429 feet north from Princeton Street.
Warren . .	F North side, 288 feet north from west line of Warren Street.

SCHEDULE No. 5.—High Service.

LIST OF HYDRANTS SET IN 1882.

STREETS.	LOCATION.
Eleventh . .	P South side, 281 feet west from Beacon Street.
Fairview . .	P South side, 316 feet east from Fairmount Street.
Premont . .	P East side, 282 feet south from Sixth Street.
Fairmount . .	P West side, 346 feet south from Hydrant opposite residence of Col. Pinder.
Fairmount . .	P West side, 653 feet south from Hydrant opposite residence of Col. Pinder.
Fairmount . .	P West side, opposite residence of James Ferguson.
Mansur . .	P South side, 166 feet west from Belmont Ave.

F denotes flush hydrant.

P denotes post hydrant.

SCHEDULE No. 6.—Low Service.

LIST OF GATES SET IN 1882.

STREETS.	LOCATION.	8 inch.	6 inch.	4 inch.
Bridge . .	14.3 feet west from the east line of Bridge Street. 12 feet north from 3-way connecting Poor Farm Road.		1	
Belmont . .	9½ feet west from the east line of Belmont Street. 3 feet south from the north line of Pine Street.		1	
Edson . .	22 feet west from the east line of Edson Street. 6 feet north from the north line of Westford Street.		1	
E. Merrimack	16 feet south from the north line of East Merrimack Street. 4 feet west from west line of Stackpole Street.		1	
Hastings . .	10.5 feet east from the west line of Hastings Street, on north line of Liberty Street.		1	
Harrison Ave.	9.4 feet south from the north line of Harrison Ave. 6.3 feet west from west line of Bridge Street.			1
Kinsman . .	11 feet south from the north line of Kinsman Street. 2 feet west from southwest line of Crosby Street.		1	
Moore . .	17.5 feet south from the north line of Moore Street. 10 feet west from west line of Bleachery Street.			1
Main . .	11 feet east from west line of Main Street. 1.5 feet south from north line of Lincoln Street.		1	
Mason . .	8.5 feet south from north line of Mason Street. 4 feet west from west line of Powell street.		1	
Otis . .	12.5 feet east from west line of Otis Street, on north line of Moore Street.			1
Pine Hill . .	11 feet east from west line of Pine Hill Street. 2 feet north from north line of Chambers Street.		1	
Plain . .	15 feet north from south line of Plain Street 6.5 feet east from east line of Chelmsford Street.		1	
Sargent . .	13 feet north from south line of Sargent Street. 3 feet west from west line of School Street.		1	
West . .	28.5 feet west from east line of West Street. 1.7 feet south from north line of River Street.		1	
Weare . .	18 feet north from south line of Weare Street. 6 feet east from west line of Grand Street.		1	

SCHEDULE No. 7.—High Service.

LIST OF GATES SET IN 1882.

STREETS.	LOCATION.	8 inch.	6 inch.	4 inch.
Beacon .	13½ feet east from the west line of Beacon Street, on the north line of Tenth Street.		1	
Fairview .	16 feet north from the south line of Fairview Street. 2 feet east from the east line of Fairmount Street.		1	

SCHEDULE No. 8.

PROPERTY AT PIPE YARD JAN. 1, 1883.

PIPE AND SPECIALS.

4-Ways.—1 2x1½-inch, 1 2x1-inch, 2 2x1-inch, 1 1½x1-inch, 16 1x1-inch, 11 1x½-inch, 35 ¾-inch. **3-Ways.**—3 2x2-inch, 7 2x1½-inch, 5 1½x1-inch, 2 1½x1-inch, 8 1½x1-inch, 3 1½x1-inch, 7 1-inch, 9 1-inch. **Elbows.**—5 2-inch, 9 1½-inch, 175 ¾-inch, 5 ½-inch, 11 1½-inch, 23 1x1-inch, 1 2x1-inch, 16 1½-inch. **Turns.**—7 1-inch, 9 ¾-inch. **Wrought Iron Pipe.**—10 feet 2½-inch, 20 feet 2-inch, 75 feet 1½-inch, 100 feet 1-inch, 100 feet ¾-inch, 30 feet ½-inch. **Lead Connections.**—2 2-inch, 10 1-inch, 15 ¾-inch, 10 1-inch for cement pipe, 14 ¾-inch for cement pipe, 11 ¾-inch for

Tools at Filter Inlet.

2 iron-tooth rakes, 11 shovels, 1 rammer, 1 axe, 2 ice-chisels, 1 gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow. The above named property is valued at \$20.00.

Tools at Reservoir.

1 grindstone, 2 iron rakes, 3 forks, 6 shovels, 1 sod cutter, 1 axe, 1 saw, 2 hoes, 2 scythes, 2 snaths, 1 grass hook, 1 wheelbarrow, 1 coil rope, 2 spare screws, 2 thermometers, 1 lantern, 1 snow shovel, 1 iron bar. The above named property is valued at \$25.00.

Property in Water Board and Superintendent's Office.

17 chairs, 2 high stools, 1 letter press, 3 desks with drawers, 3 standing desks, 1 roll-cover desk, 3 office tables, 1 book-case, 1 clock, 3 thermometers, 5 ink stands, 1 tumbler, 4 maps of Lowell, 1 map of water-distributing pipes, 3 waste baskets, 3 mats, 3 hat-racks, 6 spittoons, 8 assorted wrenches, 1 tin match-safe, 1 lantern, 1 water-gauge, 1 apparatus for sealing gates, 2 screw drivers, 2 monkey wrenches, 2 files, 1 safe, 1 key-rack, 2 picks, 1 steel prodding bar, 1 shovel, 1 atlas of Lowell, 1 atlas of Middlesex County, 1 black-walnut book-case. The above named property is valued at \$500.00.

Property and Tools at Engine House.

1 vise, 1 work bench, 1 portable forge, 8 sets brasses for engine, 2 sets differential blocks, 1 piece 2-inch rope, 2 sets fire irons, 1 brass hydrant, 3 axes, 11 wrenches, 1 hand-saw, 2 jack-screws, 26 cold-chisels, 1 ratchet drill, 1 socket-drill, 3 calking chisels, 1 barometer, 2 thermometers, 1 water cooler, 1 desk, 1 indicator, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crowbars, 64 feet $\frac{1}{2}$ -inch chain, 16 eyebolts, 1 truck, 1 key wrench, 1 wrench for air pump, 1 iron wheelbarrow, 2 hand saws, 1 buck-saw, 1 saw-horse, 2 gas lamps, 1 high grade thermometer, 4 brass bolts $1\frac{1}{2}$ -inch diameter for pump valve, 5 spare pump valves, 5 sets spare weights for valves, 11 socket wrenches, 7 pairs gas tongs, 11 finished wrenches Morris engine, 11 finished wrenches Worthington engine, 3 sledge hammers, 12 drills, 1 black-walnut cabinet, 9 chairs, 2 lengths hose, 6 copper lamps, 4 shovels, 1 floor brush, 100 bolts assorted sizes, 2 bit-stocks, 3 bits, 1 25-foot ladder, 1 20-foot, 1 8-foot, 1 pair steps, 1 hoe, 2 racks, 1 small die plate, 1 fore-plane, 3 monkey wrenches, 100 feet 2-inch rope, 4 chisel bars, 6 small taps, 4 finished socket wrenches Worthington engine, 2 14-quart iron pails, 4 hand hammers, 1 extra set grates for boiler, 1 grindstone, 1 anvil, 2 shovels, 1 clock. The above named property is valued at \$105,300.00.

ELEVENTH
ANNUAL REPORT
OF THE
LOWELL WATER BOARD
TO THE CITY COUNCIL,

***ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF THE
SUPERINTENDENT OF WATER WORKS TO THE WATER BOARD.***

JANUARY 15, 1884.

LOWELL, MASS.:
COURIER PRESS: MARDEN & ROWELL.
1884.

CITY OF LOWELL.

IN WATER BOARD, January 15, 1884.

Read and accepted, and ordered to be transmitted to the City Council.

Attest.

HORACE H. KNAPP, CLERK.

IN COMMON COUNCIL, January 15, 1884.

Read, and sent to the Board of Aldermen.

DAVID CHASE, CLERK.

IN BOARD OF ALDERMEN, January 15, 1884.

Received and read.

DAVID W. O'BRIEN, CITY CLERK.

WATER BOARD, 1884.

President ALBERT A. HAGGETT.

Term expires first Monday in May, 1885.

CHARLES C. HUTCHINSON.

Term expires first Monday in May, 1884.

Alderman GEORGE W. FIFIELD.

Councilman EDWARD B. PEIRCE. Councilman JOHN J. HOGAN.

Clerk HORACE H. KNAPP.

Superintendent of Works HORACE G. HOLDEN.

Foreman of Works THOMAS DOYLE.

Engineer at Pumping Station JAMES P. ROBERTS.

Service Clerk LEONARD T. FARRIS.


Meter Clerk WILLARD S. KNOWLTON.

Inspectors.

JOHN J. BANCROFT, ANDREW J. DEVOLL, THOS. G. GERRISH, JR.

Inspectors of Meters.

HENRY E. SPRAGUE, CHARLES H. HARVEY, TIMOTHY H. BRENNAN.

 The Water office is open dally, from 9 A. M. to 12 M.; and from 2 to 5 P. M., and on Monday evenings, from 7 to 8 o'clock.

REPORT OF THE WATER BOARD.

OFFICE OF LOWELL WATER BOARD,

LOWELL, MASS., Jan. 15, 1884.

To the City Council of the City of Lowell :

GENTLEMEN — The Lowell Water Board, in herewith presenting this, the Eleventh Annual Report of the Board regarding the condition of the Works under its care and management, is much gratified in congratulating the City Council and the citizens of our municipality upon the continued prosperity of this important branch of our public works, as shown by the abundant supply of pure water furnished, excellent condition of all portions of the Works, and the still continued increase in the water rates received therefrom — the latter being \$12,185.03 in excess of the receipts for the year 1882.

For this excellent condition of the affairs committed to our charge we desire to thank the City Council of 1883 for its kind co-operation in furnishing the Board with the necessary appropriation for the year just closed, by which we have been enabled to meet the many calls for extensions of pipe, and all the necessary expenditures for the proper care and support of the Works, by which the resultant increase in water-rates is made possible,—this, with the faithful and efficient work of those in the active charge of the Works, from the superintendent to the lowest subordinate employed

LICENSING PLUMBERS AND PIPE-FITTERS.

On March 2nd, the Board, after due consideration, and consultation with regular plumbers and pipe-fitters of the city, petitioned the City Council for the enactment of an ordinance authorizing the Lowell Water Board to license plumbers and pipe-fitters — said licensed plumbers and pipe-fitters, only, to be allowed to prosecute their calling in connection with the pipes connected with the Water Works. The suggestions considering the need of such an ordinance were fully set forth by our immediate predecessors in the Tenth Annual Report of the Water Board, and met our hearty commendation. On May 22nd, the Joint Committee on Ordinances and Legislation of the City Council reported that they found no authority by which the power to license can be granted to any branch of the "City Government," saying, "the power, as we believe, by the Charter and Public Statutes, is vested in the Board of Aldermen, and cannot be delegated or transferred except by statute law, and, as far as we know, no such statute exists; we would therefore most respectfully report, inexpedient to legislate." This report was accepted by the City Council.

We still believe in the propriety of such action as was recommended by the Water Board of 1882 concerning this important subject, and if not deemed advisable to petition the Legislature for the passage of an act authorizing the Water Board to issue such licenses, would respectfully urge that the Board of Aldermen exercise such authority, and grant such licenses through the recommendation of the Water Board. By

every particle of sediment therein contained is forced therefrom, as well as the often cleaning out of the pump-well at the pumping station, is sufficient evidence that the necessary care is taken in this direction; while the further fact that the Water Board, in the discharge of the high trust committed to their care, often resort to chemical analysis in order to ascertain the character of our water for purity — the last analysis of which was had Sept. 19th, 1883 — is further evidence of a proper regard for the protection of our citizens from a tainted supply of water.

The analysis above mentioned was made by S. P. Sharples, the State Assayer of Massachusetts, and was of three samples of water, viz.: One of city water, drawn at the Government Building, one of Pentucket spring water, located on the bank of the Merrimack River, below Hunt's Falls, in Belvidere, and one of water from a well on the Lawrence Corporation, long in use, and considered good water. The results of the analysis are shown in the following report of the State Assayer. These samples contained in 100,000 parts the following : —

	Quality.	Inorganic Matter.	Volatile & Organic Matter.	Total Residue at 212° F.	Ammonia Free.	Ammonia Albuminoid.	Nitrates.	Chlorine in Chlorides.	Sulphate of Lime.
City Water,	Excellent.	2.00	3.00	5.00	Traces.	.0100	None.	Present.	Present.
Pentucket Sp'g do.,	"	4.00	3.50	7.50	"	.0040	"	"	"
Well do.,	Good.	6.00	5.00	11.00	"	.0060	"	Strong.	Strong.

We would also call attention to an analysis of our city water made by W. P. Atwood, Esq., chemist for the Hamilton Manufacturing Company of this city, at the request of the proprietors of the Daily Citizen,

Charges for Water by Months, from Commencement to December 31, 1883.

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
January.....	. . .	\$ 303 04	\$ 418 96	\$ 150 45	\$ 126 51	\$ 160 13	\$ 282 44	\$ 233 73	\$ 182 38	\$ 233 37	\$ 271 52
February.....	. . .	35 53	235 43	238 25	86 84	144 38	226 19	349 08	146 40	139 22	136 06
March.....	\$ 6,124 04	50,200 10	65,417 68	82,249 51	89,177 52	82,225 43	80,603 69	80,507 44	89,210 88	90,856 37	94,956 65
April.....	785 80	1,739 56	935 20	266 34	584 11	1,970 12	9,242 84	6,478 39	540 20	403 64	263 10
May.....	3,988 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61	1,191 41	984 84
June	5,818 78	2,865 86	2,987 43	4,460 91	2,389 52	3,903 69	6,126 86	808 08	12,574 25	16,401 62	17,757 44
July.....	4,833 52	1 889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	873 00	959 80	1,059 37
August	2,728 30	498 50	449 86	771 87	795 88	677 01	563 35	459 17	514 46	624 40	902 76
September.....	2,827 07	3,245 06	865 90	496 97	3,433 90	4,908 07	6,584 86	8,108 23	10,088 19	10,904 30	12,467 32
October.....	9,729 05	872 10	2,947 93	4,893 44	543 79	663 80	464 29	328 51	309 22	552 27	941 81
November	761 21	634 03	573 35	1,445 65	518 72	1,220 27	1,405 89	620 56	973 16	378 97	1,615 65
December.....	1,571 72	3,689 79	3,955 39	3,246 39	4,010 71	4,522 75	5,794 77	7,851 52	9,583 32	10,848 08	12,512 70
Totals.....	\$30,168 64	\$69,307 30	\$82,861 60	\$90,674 83	\$98,178 94	\$102,877 32	\$115,201 20	\$118,808 70	\$125,975 27	\$133,503 45	\$143,809 22
Less abatements to date.....	. . .	1,572 83	640 06	8,185 88	2,502 65	4,343 13	9,590 05	1,702 13	3,766 88	2,490 50	2,552 40
Net amounts.....	\$30,168 64	\$67,434 50	\$82,221 54	\$90,489 05	\$95,676 28	\$98,534 19	\$105,671 15	\$117,106 57	\$122,208 39	\$131,012 95	\$141,316 82

<i>Amounts brought forward,</i>	\$20,976 29	2,323,048 97
Lumber	203 96	
Valves and cocks	441 93	
Hydrants	920 37	
Hydrant covers, frames and boxes .	290 40	
Labor on same	14 75	
Packing	101 00	
Gates for mains	242 65	
Gate boxes	149 52	
Service caps	32 15	
Paving, labor	37 99	
	<hr/>	
	\$23,411 01	

Labor, pay-roll on acct. of—

Extensions	\$3,769 86	
Services	2,397 80	
Piping	839 54	
Teaming	630 00	
	<hr/>	
	\$7,637 20	

Total construction account . . . \$31,048 21

MAINTENANCE.

EXPENDED FOR REPAIRS, CURRENT EXPENSES,

PUMPING, &C., VIZ. :—

REPAIRS.

Labor, pay-roll	\$3,701 40
Lumber	268 66
Wrought-iron pipe and fittings . .	244 84
Supplies	219 13
Iron and steel	126 75
Hardware, lead, &c.	155 30
Oil, fuel, &c.	12 79
Repairing drains, drinking fountains, &c.	124 85
Pump, hose and couplings	58 42
Stone, brick, lime, sand and cement .	67 85
	<hr/>
Total repairs	\$4,979 99

Amount carried forward, \$2,323,048 97

Amount brought forward, **\$2,223,048 97**

METER ACCOUNT.

Meters purchased	.	.	.	.	\$4,964 63
Labor, pay-roll	.	.	.	\$2,507 18	
Repairs on meters	.	.		230 29	
Teaming	.	.	.	27 75	
Freight paid on meters	.			39 93	
Supplies	.	.	.	9 50	
				<hr/>	\$2,814 65
Total meter account	.	.	.		<hr/> \$7,779 28 <hr/>

RECAPITULATION.

Total construction account	.	.		\$31,048 21
Repairs	.	.	.	\$ 4,979 99
Current expenses	.	.		10,476 70
Pumping account	.	.		10,600 31
Reservoir account	.	.		788 74
Meter account	.	.	.	<hr/> 2,814 65
Total maintenance account	.	.		\$29,660 39
Meters purchased	.	.	.	<hr/> 4,964 63 <hr/>
Amount expended for the year, exclusive of interest	.	.	.	\$65,673 23
Interest paid during the year	.	.		<hr/> 114,040 00 <hr/>
Total expenditures for the year	.	.	.	\$179,713 23
				<hr/> \$2,502,762 20 <hr/>

CREDITS.

**Amounts received by the City Treasurer during
the year for water rates, service pipe and
sundries, viz. :**

For account of 1882	.	.	\$ 13,405 71
“ 1883	.	.	139,177 28

Total receipts for the year **\$152,582 99**

Net cost of Works, including interest on Water Loan,
to January 1, 1884

\$2,350,179 21

The following table will show the expenditures and receipts of the Works from 1873 to 1884, exclusive of the interest on the water debt:—

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873	\$188,376.59	\$ 57,739.48	\$130,637.11	
1874	128,105.63	80,625.65	47,479.98	
1875	170,095.78	94,908.14	75,187.64	
1876	115,012.24	98,815.54	16,196.70	
1877	53,988.72	100,826.63		\$46,837.91
1878	49,900.15	104,142.87		54,242.72
1879	42,157.82	110,185.34		68,027.52
1880	45,031.59	123,740.49		78,708.90
*1881	121,601.27	128,053.97		6,452.70
†1882	64,525.92	140,397.96		75,872.04
1883	65,673.23	152,582.99		86,909.76

* In 1881 there were expended the following extraordinary amounts:

For river crossing, 24-inch reserve line	\$ 9,988 59
high service water supply	57,969 39

† In 1882 " " 	10,898 59
---	-----------

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68 and \$86,770.63, substantially.

Department to the steamer Pioneer, and then conveyed down the beautiful Pawtucket and Providence Rivers to the grounds of the Vue de l'Eau Club, where the proverbial Rhode Island hospitality was bountifully exemplified.

At the second annual meeting of the Association, held in Worcester, Mass., June 21, 1883, an invitation was extended to the Association, by Mr. Holden, our Superintendent, to hold the third annual meeting in this city on Thursday and Friday, June 19th and 20th of the present year. This invitation was accepted, and Lowell will have the honor and pleasure of entertaining this important Association at that time. The Water Board bespeak the kind co-operation of the City Council in rendering the visit one of pleasure and profit. At the meeting the following topics have been named for discussion, viz.: —

1st. Service Pipes, Material, Size, &c.—the discussion to be opened by a paper to be presented by W. H. Richards, Superintendent of the New London (Conn.) Works.

2d. Filtration of Water—the discussion to be opened by a paper to be presented by H. W. Rogers, Superintendent of the Lawrence (Mass.) Works.

During the past year the Works have suffered a great loss in the death of Daniel D. Frazer, who for several years past had faithfully filled the responsible position of Foreman of the Works. Mr. Frazer had been connected with this Department since the commencement of the Water Works, in various positions, in all of which he displayed remarkable energy and judgment, and was always faithful in the performance

VAN B. SLEEPER, *City Treasurer and Collector of the City of Lowell, in acc't with* LOWELL WATER WORKS.

DR.			CR.		
1883.			1883.		
Jan.	Balance,	\$ 411 03	Jan.	Salaries,	\$ 158 33
"	Appropriation,	26,000 00		Draft,	3,062 86
"	Water Receipts,	6,449 12		Interest,	2,160 00
"	Milton Fox. not taken,	2500 00	Feb.	Salaries,	158 34
"	Sundry ac'ts, "	165 68		Draft,	2,404 39
Feb.	Water Receipts,	5,431 89		Interest,	60 00
Mar.	" "	1,086 10	Mar.	Salaries,	158 33
Apr.	" "	6,580 89		Draft,	2,607 94
May,	" "	27,175 95		Interest,	60 00
June.	" "	50,343 62	Apr.	Salaries,	158 33
July,	" "	19,353 16		Draft,	13,933 91
Aug.	" "	11,650 81		Interest,	1,805 00
Sept.	" "	5,651 17	May,	Salaries,	158 34
Oct.	" "	8,125 10		Draft,	8,001 71
Nov.	" "	7,094 74		Interest,	47,964 65
Dec.	" "	4,207 49	June,	Salaries,	158 33
				Draft,	9,396 10
				Interest,	6,296 30
			July,	Salaries,	158 33
				Draft,	4,285 45
				Interest,	1,170 00
			Aug.	Salaries,	158 34
				Draft,	4,306 36
				Interest,	240 00
			Sept.	Salaries,	158 33
				Draft,	4,117 36
				Interest,	210 00
			Oct.	Salaries,	158 33
				Draft,	3,934 95
				Interest,	1,715 00
			Nov.	Salaries,	158 34
				Draft,	4,672 90
				Interest,	46,810 00
			Dec.	Salaries,	158 33
				Draft,	3,049 30
				Interest,	6,116 10
				Balance,	1,946 47
<hr/> <hr/>			<hr/> <hr/>		
\$182,226 75			\$182,226 75		

ELEVENTH ANNUAL REPORT
OF THE
CITY ENGINEER TO THE WATER BOARD.

JANUARY 1, 1884.

REPORT OF THE ENGINEER.

OFFICE OF CITY ENGINEER,
LOWELL, MASS., Jan. 1, 1884.

To the Lowell Water Board :

GENTLEMEN—The undersigned respectfully submits the Eleventh Annual Report of the work done by the pumping-engines at the Pumping-Station, calculated from the records kept by Mr. James P. Roberts, the Engineer in charge.

No “duty” has been calculated for the high-service engine, because it takes the steam from the same boilers and at the same time the other engines are pumping, and the coal used can only be approximately ascertained. The cost of pumping one million gallons of water from the low-service reservoir to the high-service reservoir, is about eleven dollars and forty-eight cents, which added to the cost of raising the same quantity into the low-service reservoir, makes the total cost of raising one million gallons into the high-service reservoir, approximately, twenty dollars and fifty-one cents.

It has often been remarked that the old reservoir ought to have been located where the high-service reservoir is built. If it had been, and all the water raised to that height, the cost of pumping this year would be \$13,804.06, instead of \$9,629.25; and the

proportion used in the high-service district is less than one-fiftieth of the total consumption. This seems to prove the practical economy and wisdom of the present locations of the reservoirs.

The accompanying diagram, which shows the yearly rain-fall, was made from data kindly furnished me by James B. Francis, Agent of the Locks and Canals Company, from their record taken at the Pawtucket dam. It would make quite a valuable addition to the records if a rain-gauge be placed at the Beacon-Street reservoir, which could be kept by the keeper.

Table showing work done with Morris Engine (Beam and Fly-Wheel) and Boilers, for each month during the year 1883.

MONTHS.	No. of days' pump-ing.	Av'e No. of hours' pump'g per day.	No. of hours' pump'g per month.	No. of strokes made per month.	Av'e No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quantity pumped per day, in U. S. gallons.	No. gallons of water raised in reservoir per lb., of total coal consumed.	Duty in lbs. 1 foot high, with 100 lbs. coal, used in pumping only, no deduction for ashes or clinkers.	Duty on total coal consumed, no deduction for ashes or clinkers.
January . . .	31	12-56	401-05	288,240	11.97	168.8	92,236,800	2,975.380	548	90,530,116	77,176,475
February . . .	23	13-33	311-45	218,380	11.67	166.1	69,881,600	3,038,330	547	88,423,684	75,692,880
March . . .	31	12-41	293-10	285,600	12.11	166.2	91,392,000	2,948,129	555	90,510,541	76,878,446
April . . .	1	12-40	12-40	8,943	11.76	166.0	2,861,760	2,861,760	530	89,979,192	73,316,376
May . . .	2	8-35	17-10	11,609	11.27	166.1	3,714,880	1,857,440	554	93,498,608	76,752,589
June . . .	9	14-34	131-10	91,653	11.65	166.7	29,328,960	3,258,773	555	83,581,693	77,097,590
July . . .	25	16-47	419-45	284,718	11.30	167.0	91,109,760	3,644,390	568	86,491,074	79,050,285
August . . .	28	16-12	453-55	315,953	11.60	167.9	101,104,960	3,610,891	578	87,195,075	80,911,656
September . .	22	16-15	357-40	254,139	11.84	168.3	81,324,480	3,696,567	571	88,485,529	80,153,683
October . . .	28	11-42	327-35	234,166	11.92	166.2	74,933,120	2,676,183	553	92,291,169	76,620,894
November . .	25	12-22	309-10	220,890	11.91	165.8	70,684,800	2,827,392	571	95,102,880	78,957,683
December . .	29	13-35	394-15	297,254	12.57	166.1	95,121,280	3,280,044	578	93,518,614	80,093,812
Totals and av'ges.	254	13-29	3,529-20	2,511,545	11.86	166.8	803,694,400	3,164,151	563	89,739,070	78,309,950

Table showing amount of coal, etc., used for Morris Engine at Pumping Station, during the year 1883.

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal con- sumed.
January . .	18,600	143,330	6,200	168,130
February . .	13,800	109,400	4,600	127,800
March . . .	18,600	139,860	6,200	164,660
April . . .	800	4,400	200	5,400
May . . .	900	5,500	300	6,700
June . . .	3,000	48,750	1,100	52,850
July . . .	9,600	146,610	4,200	160,410
August . .	9,000	162,250	3,600	174,850
September .	9,000	128,910	4,400	142,310
October . .	16,800	112,460	6,200	135,460
November .	15,000	102,700	6,000	123,700
December .	17,400	140,800	6,200	164,400
Totals . .	132,500	1,244,970	49,200	1,426,670

Table showing amount of coal, etc., used for the Worthington Duplex Engine, at Pumping Station, for each month during the year 1883.

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal con- sumed.
January . .	3,300	20,910	900	25,110
February . .	3,000	29,910	1,000	33,910
March . . .				
April . . .	14,400	134,350	5,400	154,150
May . . .	18,000	155,390	6,400	179,790
June . . .	8,100	124,660	3,300	136,060
July . . .				
August . .				
September .	1,200	9,950	400	11,550
October . .				
November .				
December .				
Totals . .	48,000	475,170	17,400	540,570

PUMPING STATION, MORRIS ENGINE.

Running Expenses for the year 1883.

Pay of engineer and firemen	\$2,298 61
236 $\frac{6}{10}$ tons coal, (Powelton) 1882, at \$5,37 . . .	1,269 17
476 $\frac{2}{10}$ tons coal, (Powelton) at \$4,99	2,380 18
1 $\frac{3}{4}$ cords wood, at \$4,00	5 50
Gas for lighting works	36 38
311 lbs. tallow, at 9 $\frac{1}{2}$ c.	29 54
64 gallons mixed oil	38 75
28 $\frac{1}{2}$ gallons cylinder oil	21 56
50 $\frac{1}{2}$ gallons crude oil, at 22c.	11 11
103 lbs. cotton waste, at 12 $\frac{1}{2}$ c.	12 88
55 $\frac{1}{2}$ lbs. soapstone packing, at 30c.	16 65
6 lbs. hemp packing, at 35c.	2 10
4 $\frac{1}{4}$ lbs. asbestos packing	1 25
Repairs on engine and pump	675 53
Repairs on boilers	20 99
Sundries	48 55
Total	\$6,868 75

Cost of raising water into reservoir, per million gallons,	\$8 55
Cost of raising water one foot high, per million gallons,	.05 12 ₁₀₀

WORTHINGTON ENGINE.

Running Expenses for the year 1883.

Pay of engineer and firemen	\$1,014 69
257 $\frac{72}{100}$ tons coal, (Powelton) 1882, at \$5,37 . . .	1,382 02
12 $\frac{1}{2}$ tons coal, (Powelton) at \$4,99	64 50
1 cord wood, at \$4,00	4 00
Gas for lighting works	13 45
33 gallons cylinder oil	24 94
50 lbs. cotton waste, at 12 $\frac{1}{2}$ c.	6 25
26 lbs. soapstone packing, at 30c.	7 80
Repairs on engine and pump	4 50
Repairs on boilers	8 99
Sundries	14 17
Total	\$2,545 31

Cost of raising water into reservoir, per million gallons,	\$10 66
Cost of raising water one foot high, per million gallons,	.06 43 ₁₀₀

The following table shows the average monthly and daily consumption of water for the year 1883.

MONTHS.						Gallons per month.	Gallons per day.
January	.	.	.	.	.	103,591,210	3,341,650
February	.	.	.	.	.	85,929,340	3,068,900
March	.	.	.	.	.	89,693,120	2,893,330
April	.	.	.	.	.	73,098,070	2,436,600
May	.	.	.	.	.	84,650,690	2,730,670
June	.	.	.	.	.	87,237,710	2,907,920
July	.	.	.	.	.	92,652,300	2,988,780
August	.	.	.	.	.	99,844,150	3,220,780
September	.	.	.	.	.	87,313,080	2,910,440
October	.	.	.	.	.	74,652,800	2,408,160
November	.	.	.	.	.	71,244,880	2,374,830
December	.	.	.	.	.	94,981,470	3,063,920
Total and average.						1,044,888,829	2,862,710

Respectfully submitted.

GEO. E. EVANS, *City Engineer.*

ELEVENTH ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS,
TO THE
LOWELL WATER BOARD.

JANUARY 1, 1884.

REPORT OF THE SUPERINTENDENT.

SUPERINTENDENT'S OFFICE, CITY HALL.

LOWELL, January 1, 1884.

To the Lowell Water Board:

GENTLEMEN — In accordance with the requirements of the city ordinance I respectfully submit herewith the eleventh annual report of the Superintendent of the Lowell Water Works for the year ending December 31st, 1883.

The total amount of water pumped during the year is 1,042,490,500 gallons, making an average amount used per day for each inhabitant of 40.8 gallons. This includes all the water used for manufacturing purposes, street fountains, extinguishing fires, sprinkling streets, &c. The total amount of water sold by meter measurement is 260,225,000 gallons. During the year an unusual amount of labor has been expended on repairs, especially on street-gate boxes, flush hydrant boxes, and service boxes. Many of these wooden boxes have now been in the ground over eleven years, and being subjected to the action of damp earth on the outside, and dead air on the inside, it has caused them to decay more rapidly than would be done under ordinary circumstances.

Oct. 19th, accompanied by the president of the Water Board and the City Engineer, the annual inspection of the filter gallery was made. The masonry was all in good condition, and there was no perceptible increase of sediment in the gallery.

WATER TAKERS.

The whole number of water takers (which include each family, shop, store, office, and any other such place where city water is used) is estimated to be 13,800. The number of abatements made during the year is 221, to wit: —

ON ACCOUNT OF	1882.	1883.	Total.
Water	\$360 47	\$1,379 89	\$1,740 36
Sundries	77 46	29 76	107 22
Pipe, etc. . . . .	. . . .	20 07	20 07
Totals	\$437 93	\$1,429 72	\$1,867 65

NUMBER AND KIND OF SERVICES CHANGED DURING THE YEAR

SIZE OF SERVICES CHANGED FOR		1 inch.	1½ inch.	1½ inch.	2 inch.	Total.
37	¾ inch.	1,334	. . . .	. . . .	. . . .	1,334 ft.
1	¾ inch.	. . . .	38	. . . .	. . . .	38 "
25	¾ inch.	. . . .	. . . .	1,174	. . . .	1,174 "
3	¾ inch.	. . . .	. . . .	. . . .	124	124 "
5	1 inch.	. . . .	. . . .	618	. . . .	618 "
12	1 inch.	. . . .	. . . .	. . . .	355	355 "
1	1½ inch.	. . . .	. . . .	. . . .	60	60 "
84 Totals . . .		1,334	38	1,792	539	3,703 ft.

In conclusion, I desire to express my thanks to the president and members of the Water Board for their courteous treatment and hearty co-operation in the management of the Works. Hoping that the future may be crowned with efficiency and increased prosperity, the above report is respectfully submitted.

HORACE G. HOLDEN, *Sup't.*

SCHEDULE No. 1.--Low Service.—Concluded.

SCHEDULE No. 3.—LOW SERVICE.

LIST OF HYDRANTS SET FOR THE YEAR ENDING DEC. 31, 1883.

STREETS.	LOCATION.
Brooks,	North side, 150 feet east from Willie Street.
Chelmsford,	East side, 25 feet southerly from Grand Street.
Cosgrove,	South side, 467 feet east from Gorham Street.
E. Merrimack,	North side, 466 feet east from Stackpole Street.
Gorham,	West side, 1400 feet south from hydrant at entrance to Edson Cemetery.
Jenness,	North side, 543 feet west from Chelmsford Street.
Leverett,	East side, 216 feet south from south line Leverett Street.
Lawrence,	East side, 291 feet north from Moore Street.
Middlesex.	South side, 214 feet east from King Street.
Pawtucket,	South side, 147 feet east from Cheever Street.
So. Loring,	West side, 763 feet south from Liberty Street.
So. Whipple,	West side, 1 foot south from Barrington Street.
Stevens,	West side, 283 feet south from Middlesex Street.
Wachusett,	West side, 301 feet south from Thirteenth Street.
Ware,	West side, 7 feet south from Ralph Street.
Westford,	North side, 765 feet west from Belmont Street.
West Adams,	North side, 292 feet east from Wilder Street.

The above list are all post hydrants.

TWELFTH
ANNUAL REPORT
OF THE
Lowell Water Board
TO THE
CITY COUNCIL

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF
THE SUPERINTENDENT OF WATER WORKS, TO THE
WATER BOARD

JANUARY 12, 1885.

LOWELL, MASS.
HARRINGTON BROTHERS, PRINTERS, SUN OFFICE.
1885.

42852

1885

CITY OF LOWELL.

IN COMMON COUNCIL, JAN. 13, 1885.

Read and sent to the Board of Alderman.

DAVID CHASE, *Clerk.*

IN BOARD OF ALDERMEN, JAN. 13, 1885.

Read and ordered placed on file.

SAMUEL M. CHASE, *City Clerk.*

CIVIL ORGANIZATION, LOWELL WATER WORKS

From their commencement to Jan. 1, 1885.

JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Cyrus H. Latham, alderman.
William H. Anderson, councilman.
Frederick T. Greenhalge, councilman.
Albert A. Haggett, councilman.
Edwin Lamson, councilman.

1871.

Edward F. Sherman, mayor.
Albert A. Haggett, alderman.
Henry P. Perkins, councilman.
Jeremiah Crowley, councilman.
William Dobbins, councilman.

1870.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Albert A. Haggett, councilman.
Wm. Kittredge, councilman.
Wm. O. Fiske, councilman.

1872.

Josiah G. Peabody, mayor.
Alexander G. Cumnock, alderman.
Henry P. Perkins, councilman.
Nathaniel C. Sanborn, councilman.
Crawford Burnham, councilman.

WATER COMMISSIONERS.

1870-'71-'72.

Levi Sprague, chairman.
Wm. E. Livingston.
Henry H. Wilder, resigned Sept. 26, 1871.
Samuel K. Hutchinson, elected to fill vacancy.

WATER BOARD.

1873.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Jonathan P. Folsom, alderman.
Nathaniel C. Sanborn, councilman.
Nathan W. Frye, councilman.

1878

Albert A. Haggett, president, from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
Charles H. Harvey, councilman.

1874.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Nathaniel C. Sanborn, alderman.
Nathaniel W. Frye, councilman.
G. W. S. Hurd, councilman.

1879.

Albert A. Haggett, president, from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
Edward B. Peirce, councilman.
Robert G. Bartlett, councilman.

1875.

Geo. Runels, pres., from the citizens, resigned
Nov. 9, 1875.
Cyrus H. Latham, president *pro tem*, from the
citizens.
Benjamin Walker, alderman.
Albert A. Haggett, councilman.
Earl A. Thissell, councilman.

1880.

Albert A. Haggett, president, from the citizens.
James W. Bennett, from the citizens.
Robert Wood, alderman.
Charles C. Hutchinson, councilman.
Edward B. Peirce, councilman.

1876.

Cyrus H. Latham, pres., from the citizens.
Earl A. Thissell, from the citizens.
Albert A. Haggett, alderman.
Benj. C. Dean, councilman, resigned May, 1876.
John F. Kimball, councilman, elected to fill
vacancy.
Orford R. Blood, councilman.

1881.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Robert Wood, alderman.
Charles C. Hutchinson, councilman.
Samuel Hosmer, councilman.

1877.

Cyrus H. Latham, president, from the citizens.
Albert A. Haggett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
James W. Bennett, councilman.

1882.

Albert A. Haggett, president, from the citizens.
Charles C. Hutchinson, from the citizens.
Thomas R. Garity, alderman.
William N. Osgood, councilman.
Frank Wood, councilman.

WATER BOARD.

1883.

Albert A. Haggett, pres., from the citizens.
Charles C. Hutchinson, from the citizens.
George W. Fifield, alderman.
Edward B. Peirce, councilman.
John J. Hogan, councilman.

1884.

Albert A. Haggett, pres., from the citizens.
C. A. R. Dimon, from the citizens.
George W. Fifield, alderman.
Edward B. Peirce, councilman.
John J. Hogan, councilman.

1885.

A. A. Haggett, pres., from the citizens.
C. A. R. Dimon, from the citizens.
James Francis, alderman.
Alfred M. Chadwick, councilman.
Arnold S. Welch, councilman.

Investigations were made at various times, by order of the City Council, for the introduction of pure water into the city, viz: By Joint Special Committees consisting of the following-named citizens:

1838.

Oliver M. Whipple, alderman.
George Brownell, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.
John Clark, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
John Nesmith, councilman.

1848.

Jefferson Bancroft, mayor.
Oliver M. Whipple, alderman.
David Dana, alderman.
John Avery, councilman.
Otis L. Allen, councilman.
Thomas Hopkinson, councilman.
Ignatius Tyler, councilman.

1865.

George W. Norris, alderman.
Edward F. Watson, alderman.
Charles W. Dodge, councilman.
T. L. P. Lamson, councilman.
John Pearson, councilman.

1866.

Josiah G. Peabody, mayor.
Charles W. Dodge, alderman.
Joseph L. Sargent, alderman.
Benjamin Walker, councilman.
Edward C. Rice, councilman.

WATER BOARD, 1885.

President ALBERT A. HAGGETT.
Term expires first Monday in May, 1885.

C. A. R. DIMON,

Term expires first Monday in May, 1886.

Alderman, JAMES FRANCIS.

Councilman ALFRED M. CHADWICK.

Councilman ARNOLD S. WELCH.

Clerk . . . HORACE H. KNAPP.

Superintendent of Works HORACE G. HOLDEN.

Foreman of Works THOMAS DOYLE.

Engineer at Pumping Station JAMES P. ROBERTS.

Service Clerk LEONARD T. FARRIS.

Meter Clerk WILLARD S. KNOWLTON.

Inspectors.

JOHN J. BANCROFT.

ANDREW J. DEVOLL.

THOS. G. GERRISH, JR.

Inspectors of Meters.

HENRY E. SPRAGUE,

THOMAS E. LENNON,

TIMOTHY H. BRENNAN.

¶ The Water office is open daily, from 9 A. M. to 3 P. M., and on Monday evenings, from 7 to 8 o'clock.

REPORT OF THE WATER BOARD.

OFFICE OF LOWELL WATER BOARD,

LOWELL, MASS., Jan. 12, 1885.

To the City Council of the City of Lowell :

GENTLEMEN—The Lowell Water Board in compliance with the Ordinances of the City of Lowell herewith present the Twelfth Annual Report of the Board :

The past year has been one of continued prosperity, and we are gratified to be able to report, notwithstanding the depression in business affairs and the consequent reduction in our sources of revenue, a substantial increase of the net charges for water during the year, of \$5000 in round numbers. The Works are in excellent condition, and in all departments have been well and carefully attended to by those in charge. For the details of work performed during the year we would refer to the Reports of the Superintendent and Engineer accompanying this Report, wherein may be found many interesting items in connection therewith. No new questions have arisen during the year regarding the administration of the Works, which would necessitate an allusion thereto in this Report, everything pertaining thereto having continued in a quiet and successful manner, and the work of the several departments having been performed with a faithful and conscientious regard to the city's interest.

1,042,490,500 U. S. gallons in 1883, and the daily average pumped was 3,157,936 gallons, against 3,021,655 gallons in 1883, an increase for the year of 62,787,100 gallons and of 136,281 gallons in the daily average.

The quantity of coal consumed during the year for all purposes, excepting for the High Service supply, was $1,042\frac{1}{2}\frac{8}{10}\frac{8}{10}$ tons against $983\frac{5}{2}\frac{2}{10}\frac{0}{10}$ tons in 1883. For the High Service supply the consumption during the year was $30\frac{2}{2}\frac{8}{10}\frac{8}{10}$ tons against $27\frac{4}{2}\frac{8}{10}\frac{5}{10}$ tons in 1883.

There have been $529\frac{1}{1}\frac{0}{10}$ gallons of water raised $165\frac{4}{1}\frac{0}{10}$ feet high for each pound of coal consumed during the year.

The total number of water takers is 14,125 against 13,800 in 1883 a gain of 325 for the year. There are now laid $77\frac{1}{1}\frac{4}{10}$ miles of street mains, the increase for the year having been $3\frac{3}{1}\frac{6}{10}$ miles. The total net charges for water rates for the year after deducting all abatements, and the charges for service pipes, have been \$145,999.93 against \$141,316.82 for the year 1883, an increase for the year of \$4,683.11.

The following table will show the monthly charges for water, from the commencement of the Works to December 31, 1884, with all abatements, and total net charges:—

FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this department for the year ending December 31, 1884, is as follows:—

For Water Rates.....	\$92,515 12	
metered water.....	56,413 73	
		<hr/>
Total for use of water.....	\$148,928 85	
For service pipe and laying.....	\$1,791 52	
meters sold.....	2,640 50	
sundry accounts.....	5,986 60	
		<hr/>
Total for pipe, meters, &c.....	\$10,418 62	
Total charges for the year.....	\$159,347 47	

The following statement exhibits the receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the net cost and expenses of the Works by taxation:—

Net cost of the Water Works to January 1, 1884, as per last Annual Report.....	\$2,350,179 21
Expended during the year for Water pipes and for laying the same and all other items of	

CONSTRUCTION.

MATERIALS FOR MAINS, SERVICES, &c.:—

Cast-iron pipe and special castings.....	\$13,902 52	
Wrought-iron pipe and fittings.....	3,605 17	
Brass connections.....	8 08	
Lead and lead pipe.....	583 99	
Teaming pipe.....	329 18	
Pipe and service joints, hardware, powder, fuse, &c.....	471 08	
Freight.....	990 54	
Lumber.....	240 86	
		<hr/>
Amounts carried forward,	\$20,131 42	\$2,350,179 21

TWELFTH
ANNUAL REPORT
OF THE
Lowell Water Board
TO THE
CITY COUNCIL

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF
THE SUPERINTENDENT OF WATER WORKS, TO THE
WATER BOARD

JANUARY 12, 1885.

LOWELL, MASS.
HARRINGTON BROTHERS, PRINTERS, SUN OFFICE
1885.

42852

1903

CITY OF LOWELL.

IN COMMON COUNCIL, JAN. 13, 1885.

Read and sent to the Board of Alderman.

DAVID CHASE, *Clerk.*

IN BOARD OF ALDERMEN, JAN. 13, 1885.

Read and ordered placed on file.

SAMUEL M. CHASE, *City Clerk.*

CIVIL ORGANIZATION, LOWELL WATER WORKS

From their commencement to Jan. 1, 1885.

JOINT SPECIAL COMMITTEES.

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Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Cyrus H. Latham, alderman.
William H. Anderson, councilman.
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WATER COMMISSIONERS.

1870-'71-'72.

Levi Sprague, chairman.
Wm. E. Livingston.
Henry H. Wilder, resigned Sept. 26, 1871.
Samuel K. Hutchinson, elected to fill vacancy.

WATER BOARD.

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WATER BOARD.

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C. A. R. Dimon, from the citizens.
James Francis, alderman.
Alfred M. Chadwick, councilman.
Arnold S. Welch, councilman.

Investigations were made at various times, by order of the City Council, for the introduction of pure water into the city, viz: By Joint Special Committees consisting of the following-named citizens:

1838.

Oliver M. Whipple, alderman.
George Brownell, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
David Dana, councilman.

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John Clark, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
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David Dana, alderman.
John Avery, councilman.
Otis L. Allen, councilman.
Thomas Hopkinson, councilman.
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George W. Norris, alderman.
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Charles W. Dodge, councilman.
T. L. P. Lamson, councilman.
John Pearson, councilman.

1866.

Josiah G. Peabody, mayor.
Charles W. Dodge, alderman.
Joseph L. Sargent, alderman.
Benjamin Walker, councilman.
Edward C. Rice, councilman.

lucrative position, and the vacancy was filled by the appointment of Mr. T. E. Lennon.

On Thursday and Friday, June 19th and 20th, of the past year the New England Water Works Association held its third annual meeting in this city, at the invitation of Superintendent Holden. The meeting was attended by a large number of the members of the Association, and was, we trust, productive of much that will pleasantly remind the members of the hospitality which is proverbial in our busy and industrious city. We desire to extend our thanks to the City Council of 1884 for the kindly assistance rendered to the Board in their efforts to make the visit of the Association a pleasant and agreeable one. That it was successful we have reason to know, by the repeated expressions of commendation given to the members of the committee in charge of the reception and entertainment of the Association, by the members thereof.

Respectfully submitted,

A. A. HAGGETT,
CHAS. A. R. DIMON,
JOHN J. HOGAN,
GEO. W. FIFIELD,
EDWARD B. PEIRCE,

Members of the Lowell Water Board.

IN WATER BOARD, JAN. 12, 1885.

Read and accepted, and ordered to be transmitted to the City Council.

Attest:

HORACE H. KNAPP,

Clerk.

VAN B. SLEEPER, *City Treasurer and Collector of the City of Lowell,*
in account with LOWELL WATER WORKS.

Dr.		Cr.	
1884.		1884.	
Jan.	To bal from old ac. \$ 1,946 47	By Payments during the year, viz:	
"	" appr'ion for 1884 16,000 00	Interest.	Salaries. Drafts. Refunds
"	" Water Receipts. 7,831 86	Jan. \$ 1,230	\$158 33 \$ 2,715 43
Feb.	" 4,065 02	Feb. 390	158 34 2,448 44
Mar.	" 2,115 67	Mar. 210	150 05 2,432 62
Apr.	" 5,521 97	Apr. 1,745	144 88 4,018 63
May	" 34,294 42	May 46,000	144 88 11,888 15 \$692 43
June	" 44,932 54	June 6,740	144 88 4,692 07 2 25
July	" 17,473 61	July 720	144 88 10,990 70 2 50
Aug.	" 11,671,39	Aug. 330	217 32 5,527 32
Sept.	" 6,392 25	Sept. 120	144 88 6,638 33
Oct.	" 9,176 19	Oct. 1,685	144 88 3,857 95 25 13
Nov.	" 7,122 97	Nov. 44,740	144 88 3,002 75 2 50
Dec.	" 4,576 37	Dec. 5,660	201 80 4,869 72 12 50
"	Transfer to bal. acc't 2,168 69	Tot. \$109,570	\$1,900 00 \$63,082 71 \$737 31
\$175,290 02		\$175,290 02	

TWELFTH ANNUAL REPORT
OF THE
CITY ENGINEER TO THE WATER BOARD.

JANUARY 1, 1885.

REPORT OF THE ENGINEER.

OFFICE OF CITY ENGINEER,

LOWELL, MASS., Jan. 1, 1884.

To the Lowell Water Board:

GENTLEMEN:—The undersigned respectfully submits the Twelfth Annual Report of the work done by the pumping engines at the Pumping Station.

The calculations of the duty of the engines were made from the records kept by Mr. James P. Roberts, the engineer in charge.

All the coal used at the station has been charged to pumping, and no deduction of any kind has been made.

The average cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is ten dollars, which, added to the cost of raising the same quantity into the low-service reservoir, makes the total cost of raising one million gallons into the high-service reservoir eighteen dollars and forty-seven cents.

During the year the Morris engine has run forty-five and the Worthington engine five nights. January 8th the Morris engine pumped 5,979,480 gallons, and June 25th the Worthington engine 5,785,110 gallons, which is the largest quantity pumped during any run of twenty-four hours.

Table showing work done with Worthington Duplex Engine for each month during the year 1884.

MONTHS.	No. of days pump- ing.	Ave. No. of hours pumping per day.	No. of hours pumping per month.	No. of strokes made per month.	Average No. of strokes made per minute.	Ave'ge head, in- cluding friction in feet	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water raised in- to reserv- oir per lb of total coal con- sumed.	Duty in lbs. 1 foot high, with 100 lbs. coal used in pump- ing only, no de- duction for ashes or clink- ers.	Duty on total coal consumed no deduction for ashes or clinkers.
January	3	14-42	44-05	34,241	12.95	163.49	10,614,710	3,538,237	440.	69,532,768	60,011,686
February	5	11-06	55-30	35,423	10.64	167.34	10,981,130	2,196,226	418.	68,674,490	58,229,711
March	8	10-58	87-45	44,437	8.44	170.64	13,775,470	1,721,934	381.	61,546,606	54,221,651
April	9	11-19	101-50	81,413	13.32	166.29	25,238,030	2,804,226	407.	66,659,787	56,349,924
May	10	10-35	105-50	80,562	12.69	165.69	24,974,220	2,497,422	437.	72,893,505	60,385,059
June*	11	14-04	154-40	106,540	11.48	167.32	33,027,400	3,002,491	417.	69,970,964	58,208,916
July*	9	14-21	129-10	96,826	12.49	165.69	30,016,060	3,335,118	426.	71,585,470	58,874,982
August											
September	4	9-34	38-15	28,971	12.62	166.19	8,981,010	2,245,252	428.	69,105,182	59,233,020
October											
November	2	12-03	24-10	16,596	11.44	165.39	5,144,450	2,572,225	422.	66,895,315	58,122,169
December	4	12-38	50-3)	34,496	11.38	164.04*	10,693,760	2,672,440	435.	68,315,612	59,429,035
Totals and Averages .	65	12-11	791-45	559,504	11.78	166.21	173,446,240	2,668,404	420.	68,954,079	58,169,307

* Engine run two nights.

Table Showing Work Done with Worthington High-Service Engine, 1884.

MONTHS.	No. of days pumping.	Average number of hours pumping per day.	Number of hours pumping per month.	Number of strokes made per month.	Average number of strokes made per minute.	Average head, including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. of Gallons of water pumped into reservoir per lb. of total coal consumed.	Coal in lbs. used when pumping.
January, . . .	5	9-12	46-00	99,759	36.14	76.82	1,396,626	279,325	319	4,380
February, . . .	4	9-20	37-20	77,795	34.73	76.35	1,089,130	272,282	320	3,400
March, . . .	5	10-32	52-40	118,386	37.46	77.74	1,657,404	331,481	326	5,080
April, . . .	4	9-14	36-55	84,237	38.03	77.51	1,179,318	294,829	323	3,650
May, . . .	5	10-07	50-35	107,248	35.34	77.51	1,501,472	300,294	319	4,700
June, . . .	5	11-21	56-45	125,726	36.92	78.20	1,760,164	352,633	320	5,500
July, . . .	7	12-26	87-00	174,991	33.52	77.90	2,449,874	349,982	310	7,900
August, . . .	7	9-57	69-40	149,815	35.84	79.66	2,097,410	299,630	328	6,390
September, . . .	5	9-39	48-15	100,267	34.63	78.43	1,403,738	280,748	297	4,730
October, . . .	6	11-50	71-00	156,687	36.78	78.85	2,193,618	365,603	325	6,750
November, . . .	3	8-53	26-40	59,030	36.89	68.27	826,420	275,473	321	2,570
December, . . .	6	9-43	58-20	115,584	33.02	78.09	1,618,176	269,696	325	4,980
Totals and averages,	62	10-20	641-10	1,369,525	35.60	77.95	19,173,350	309,248	319	60,030

RESERVOIR, 1884.

The following table shows the average depth of water, the number of gallons and the temperature of the water in the reservoir, and also the temperature of the air for each month. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 and 6 P. M.

MONTHS.	Depth in Feet.	Quantity in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air.
January	19.52	29,767,300	33.0	19.9
February.....	19.56	29,834,400	33.6	29.6
March.....	19.74	30,138,900	35.2	33.0
April.....	19.51	29,754,700	42.0	44.6
May.....	19.71	30,084,200	55.1	58.6
June.....	18.94	28,790,400	66.5	72.7
July.....	18.75	28,484,800	71.5	72.8
August.....	19.08	29,029,800	71.9	72.2
September	18.57	28,175,700	67.8	67.8
October.....	18.89	28,718,100	56.3	52.3
November.....	19.15	29,151,000	39.6	39.9
December.....	18.66	28,337,700	33.2	30.3

The following table shows the average monthly and daily consumption of water for the year 1884 :

MONTHS.	Gallons per Month.	Gallons per Day.
January	111,604,800	3,600,150
February	87,931,410	3,032,120
March	93,803,070	3,025,910
April	75,411,170	2,513,700
May	81,245,390	2,620,820
June	93,819,970	3,127,330
July	98,747,970	3,185,420
August	98,161,450	3,166,500
September	93,357,400	3,111,910
October	86,990,100	2,806,130
November	79,440,220	2,648,010
December	103,358,820	3,334,160
Total and average	1,103,871,770	3,016,040

Respectfully submitted,

GEO. E. EVANS, *City Engineer.*

TWELFTH ANNUAL REPORT
OF THE
SUPERINTENDENT OF WATER WORKS,
TO THE
LOWELL WATER BOARD.

JANUARY 1, 1885.

REPORT OF THE SUPERINTENDENT.

SUPERINTENDENT'S OFFICE, CITY HALL,

LOWELL, January 1, 1885.

To the Lowell Water Board :

GENTLEMEN—In accordance with the requirements of the City ordinance, I respectfully submit herewith the twelfth annual report of the Superintendent of the Lowell Water Works for the year ending December 31st, 1884.

The total amount of water pumped into the reservoir during the year was 1,105,277,600 gallons, an increase of 62,787,100 gallons over the amount pumped in 1883. Giving an average daily consumption of about 43 gallons of water per each inhabitant. This includes all the water that is used for manufacturing purposes as well as for domestic use, also for street drinking fountains, extinguishing fires, sprinkling streets, etc. The total quantity of water sold by meter measurement amounts to 281,946,400 gallons, an increase over last year of 21,721,400 gallons. The works and everything connected with them are in good condition, and taking into consideration that over 12 years have elapsed since the pumps were first started, the repairs so far have not been unusually large.

The filter gallery has been drawn down twice this year, June 6th and October 18th. Also at the same times, the conduit was blown off at the Beaver Brook standpipe, and the pump wells thoroughly cleaned. August 19th and 20th all the mains throughout the city were given a thorough blowing out, and since then no complaints in regard to the quality of the water have been made.

•

EXTENSIONS.

17,731 1-2 feet of cast iron pipe for mains have been laid this year, an increase of 576 1-2 feet more than were laid last year. This is the largest amount, with the exception of the year 1881, when the high service works were constructed, that has been laid in any year since 1876, and is owing to the large number of streets which have been lately laid out on the Hildreth estate and the Rogers farm.

The 24-inch reserve line across the Merrimack river at Hunt's Falls has been extended, and connections made on both sides of the river with the 12-inch high service line, so that in case of accident to the 12-inch line, the water can be turned on to the reserve line without delay.

A 20-inch blow-off has also been connected to the reserve line on the Centralville side of the river.

LEAKS.

There has been 1 leak in joint of main pipe on Mammoth street, 1 main pipe cracked on Walker street, 1 hydrant blew off on French street, and 1 leak in the cement-lined pipe on Middlesex street.

Thirteen service pipes have broken off, principally occasioned by the settling of sewer trenches.

HYDRANTS.

There have been 17 post hydrants set on extensions. The flush hydrant on Taylor street, corner of Merrill street, has been removed, and a post hydrant set on the opposite corner. New valves and other repairs have been made on 15 flush hydrants and 12 post hydrants. The hydrant on Meadowcroft street has been taken up and reset on Bolt street.

A 4-inch fire service has been put into Wm. Walker & Son's mill on Lawrence street, a 4-inch pipe has been laid into the premises of Woods, Sherwood & Co., on Bridge street, and a 4-inch fire service laid into Huntington Hall on Shattuck street.

METERS.

There are now 1,348 meters in use, an increase of 102 over last year.

The amount of service pipe laid is as follows :

Laid during 1884, $\frac{3}{4}$ inch.....	2,449 feet
“ “ “ 1 inch.....	7,276 “
“ “ “ $1\frac{1}{4}$ inch.....	86 “
“ “ “ $1\frac{1}{2}$ inch.....	863 “
“ “ “ 2 inch.....	443 “
<hr/>	
Total laid during 1884.....	11,117 feet
Add amount previously laid.....	247,203 “
<hr/>	
Total amount laid.....	258,320 feet

ITEMS OF OTHER WORK DONE.

During the past year every service box, street gate and hydrant has been inspected and put in good order. Large pipe drinking fountains have been set in place of old ones on Cabot street near Merrimack street, Middlesex street near Gorham street, Broadway near School street, Fletcher street, corner of Willie street, and Merrimack street near Bridge street. A new drinking fountain has been set on Gorham street opposite Moore street, and a self-closing fountain on Fletcher street near Dutton street. The gate houses at the filter gallery and reservoir have been repainted and whitewashed, and the reservoir grounds kept in good order. Thirty-one stop gates have been repaired and the stuffing boxes packed.

In addition to the main pipes there has been laid an amount of smaller sizes, as follows :

REPORT OF THE SUPERINTENDENT.

SCHEDULE OF SMALL PIPE LAID.

STREETS.	1 INCH.	1 1-2 IN.	TOTAL
Adams Court		234	
Anderson		190	
Canada	116		
Lawrence		190	
Manufacture		164	
Nichols		237	
Quimby Ave.	40		
Riverside Ave.	144		
Sargent		63	
West Court		109	
West Manchester	164		
Washington	21		
Wright	156		
Total	641	1187	1228

NUMBER AND KIND OF SERVICES CHANGED DURING THE YEAR.

SIZE OF SERVICES CHANGED FOR		1 inch.	1 1-4 inch	1 1-2 inch	2 inch.	Total.
49	3-4 inch.	2,157				2,157
6	3-4 inch.		159			159
21	3-4 inch.			1,194		1,194
2	3-4 inch.				80	80
78 Totals		2,157	159	1,194	80	3,590

In conclusion, I desire to express my sincere thanks to your honorable Board for the uniform kindness extended to me in the discharge of my several duties during the past year.

Respectfully submitted,

HORACE G. HOLDEN, *Sup't.*

LOW SERVICE.—WATER PIPES LAID IN 1884.

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LOW SERVICE.—WATER PIPES LAID IN 1

STREETS		BETWEEN WHAT STREETS		LENGTH		IN FEET	
Quimby Av.	Extended					78	78
River .	" n.w'ly to Dracut line			2,150	347		2,497
River connection	At Merrimack River .	185	60				245
Royal . .	Extended southerly .				2384		2384
Rogers . .	Harrison and Clay .				230		230
Stevens . .	South of Pine, extended			72			72
Shaw . .	Extended to Chelmsford				2324		2324
Tanner . .	Southw'ly from Howard				688		688
Tanner . .	Southw'ly from Lincoln					704	704
Taylor . .	Extended easterly .			13			13
Washington .	Sautherly from Leverett					4134	4134
Ware . .	Extended southerly .				604		604
West . .	Extended northerly .				412		412
West Mason	Westerly from Hastings				574		574
Woodward Av.	M'moth Road and Butler				8704		8704
Street . .	South'ly from Aiken Av.				308		308
	Hydrants				136		136
Total in feet		185	60	2,518	11,9394	2,287	16,9894
Length short'ed by relay'g Meadowcroft st					37		37
		185	60	2,518	11,9024	2,287	16,9024
Meadowcroft relaid 400 feet on account of							
change in st. lines, length now is .					1,572		1572
Length previously given, 1600—37 ft dif.							
Taylor relaid with 8-inch pipe . . .				235			235

HIGH SERVICE—WATER PIPES LAID IN 1884.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					
		24 in.	30 in.	18 in.	6 in.	4 in.	
Belmont ave, .	Mansur and Talbot, .				286		286
Mansur, .	Extended to Belmont av.				185		185
Talbot, . .	Extended to Belmont av.				297		297
	Hydrants, . . .				11		11
	Totals,				779		779

HIGH AND LOW SERVICE—SUMMARY OF WATER PIPES
LAID IN 1884.

	24 inch.	20 inch.	8 1-2 in.	6 inch.	4 inch.	Totals.
Low Service,	185	60	2,518	11902½	2,287	16,952½
High Service,				779		779
Total in feet,	185	60	2,518	12681½	2,287	17,731½
Pipes laid previous to 1884 .						389,847
Total in feet, Jan. 1, 1885						407,578½
Total in inches, Jan. 1, 1885						77.19

**LIST OF STOP GATES SET DURING THE YEAR ENDING
DEC. 31, 1885.**

Hastings	12.2 feet west from east line Hastings street; 1.0 foot south from south line Liberty.				1
Lilley Avenue	4.0 feet west from west line, 15.0 feet south from north line Lilley Avenue.				1
Maple	17.6 feet north from south line Maple Street; 1.0 feet west line Gorham Street.				1
Osgood	3.7 ft. line Westford; 13.6 feet east from West line Osgood Street.				1
River Crossing	North side of river; 20 inch—1	1	1		
	South side of river.	1	1		
Shaw	2.0 feet west from westerly line Chelmsford; 13.4 feet south from north line Shaw.				1
Tanner	19 ft. east from west line Tanner St. about on westerly line Howard street.				1
Tanner	1.5 feet southerly from south westerly line Lincoln; 15 feet northwesterly from bound southwesterly corner Lincoln and Tanner.				1
*Taylor	23 feet southerly from northerly line Taylor St. on east line Lawrence street.				1
Woodward Av.	4 feet westerly from westerly line Man. Road; 7 feet northerly from southerly line Woodward Avenue.				1

*Replaces 4-inch gate.

Wrought Iron Pipe.—100 feet 2-inch, 700 feet 1 1-2 in., 50 ft. 1-inch, 500 feet 3-4-inch. **Stop Gates.**—1 4-inch, 1 6-inch, 1 8-inch, 1 8-inch old style. **Hydrants.**—1 post, 1 flush, 18 second-hand hydrants, 7-hydrant frames and covers, 2 gate frames and covers. **Solder Nipples.** 34 1-inch, 2 2-inch 48 3-4-inch. **Tees.**—10 3-4 inch, 35 1-inch. **Crosses.**—30 3-4-inch. **Unions.** 30 5-8 inch, 40 3-4-inch, 30 5-8-solder unions, 60 right 5-8-in. solder unions, 85 1-inch. **Bushings.**—25 assorted bushings, elbows 100 assorted. **Sockets.** 13 3-4-inch sockets, 45 1-inch. **Corporation Cocks.**—14 5-8-inch, 45 1-inch. **Stop and Waste Cocks.**—18 3-4-inch, 7 1-inch, 4 5-8-inch, 1000 assorted couplings. **Lead Connections.**—80 1-inch, 8 1-2-inch. 6 iron sidewalk boxes, 100 wood sidewalk boxes. 1 hydrant box, 2 saw horses, 2 buck saws, 8 hand-saws, 1 pipe testing machine, 2 pipe benches, 4 tool boxes, 3 derricks, 1 fall rope and blocks, 2 set iron patent pully blocks, 1 chain, 4 wheelbarrows, 2 tongs for cleaning sidewalk boxes. 2 old style gate covers. 4 set castings for drinking fountains, 1 cord logs for blasting purposes, 1 1-2 tons hay, 1 1-2 tons carrots, 4 horse blankets, 2 canvass horse covers, 2 horses. 4 set harnesses, 100 feet drain pipe, 50 pick handles, 7 crowbars, 60 feet rubber hose, 1 hose reel, 2 brass goose necks for hydrants. 30 calking sets, 5 nail hammers, 300 sidewalk caps. 4 pairs rubber boots, 150 feet canvass hose, 30 iron lug straps, 250 lbs. bolts, 10 assorted files, 12 assorted gravel screens. 5 hanging irons for bridges, 10 iron bands for pipe, 75 lbs. cotton waste, 200 lbs. iron, 1 grind stone, 1 set blacksmith tools, 6 screw-drivers, 10 lbs. iron washers. 30 lbs. assorted nuts, 5 hand hatchets, 1 axe. 3 trowels, 800 lbs. steel in drills, 4 scrapers for blasting purposes, 8 lbs. pipe wedges, 3 yarning irons, 2 lead ladles. 5 sling ropes. 1 iron rake, 6 square pointed shovels, 8 wood plugs for main pipe, 5 lbs. shims and wedges, 2 tag ropes. 1 root axe, 1 dualin pot, 1 ten gallon can, 200 lbs. old brass, 2 surcingles, 2 halters, 2 pungs, 2 horse brushes, 2 hay forks, 2 manure forks, 1 wagon jack, 2 express wagons, 12 hammer handles. 1-16 foot straight edge, 10 striking hammers, 9 steel points, 400 lbs. pig lead. 3 set old blocks, 2 lead pots, 2 furnaces for melting lead, 1 zink pump, 1 Edson patent pump, 2 copper force pumps, 1 keg 10d nails, 1-4 keg 20d nails, 2 wagon wrenches, 40 assorted wrenches, 8 rammers, 3 paving mauls, 40 shovels, 50 picks, 8 draught chains, 1 bbl. cement, 1-4 bbl. white clay, 2 snow shovels, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 2 spirit levels, 1 rubber diaphragm for pumps, 200 feet lumber for repairing boxes. 1 pattern for making boxes, 17 dippers for drinking fountains, 75 feet 3-4-inch lead pipe, 150 feet block tin wire, 2 portable closets, 12 lanterns, 1-2 gross lamp wicks. 2 ratchet cutters, 4 pipe cutters, 4 pipe vices, 15 dies, 2 ratchet die plates, 3 die plates, 4 pipe tongs, 1-2-inch auger. 2 1-2-inch taps, 2 1-inch taps, 1 1 1-2-inch taps. 5 oil cans. 5 bottoms for Worthington meter, 2 lbs. sealing wax, 1 box crayons, 1-4 box wax candles, 19 assorted gate screws. 3 set packing patterns, 5 lbs. leather, 1 wire brush, 2 oil pans. 1 brass lantern, 2 brass lamps, 125 feet block tin tubing. 1 solder pot and mould, 2 pairs pliers, 1 pair cut nippers, 2 hard packings for meters, 10 valve and valve seals, 1 roll packing paper, 30 spindles to Worthington meter, 3 taping machines, 1 leather tool bag, 1 tin match safe, 2 rubber connections, 1 fore plane. 1 iron wood mallet, 3 solder irons, 1 press drill, 2 washer cutters, 1 set steel numbers, 1 lath dog, 1 foot lathe, 1 universal chuck, 1 seive, 1 iron bucket for testing meters, 3 bits, 10 ends to Worthington meter. 1 surface plate, 1 5-gal. can. 1 2-gal., 2 1-gal., 2 1-2gal., 1 quart, 1 4-quart wood measure, 1 tin tunnell, 2 desks, 1 grain box, 1 large map of main pipe, 1 10-foot ladder, 1 coal stove, 1 coal hod, 1 counter scale, 1 platform scale, 2 brooms, 4 chairs, 2 tanks for testing meters, 12 monkey wrenches, 4 Stilson wrenches. **Worthington Meters.**—2 2-inch, 2 1-2 inch. **Desper Meters.**—1 1-inch. 2 5-8-inch. **Duplex Meters.**—2 1-inch. **Fitts Rotary Meter.**—1 5-8-inch. **Crown Meter.**—10 1-inch, 28 3-4 inch, 13 5-8-inch.—**Second Hand Meters Ball and Fitts.**—3 5-8 inch. **Hydrant Packings.**—35 also 33 4-inch for tap, 33 4-inch for bottom. 34 5-inch for top, 36 5-inch for bottom. 10 packings for 4-inch gate, 12 for 6-inch gate, 6 for 8-inch gate, 3 for 12-inch, 1 for 16-inch gate.

THIRTEENTH
ANNUAL REPORT
OF THE
Lowell Water Board
TO THE
CITY COUNCIL,

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER
AND OF THE SUPERINTENDENT OF WATER WORKS,
TO THE WATER BOARD.

JANUARY 12th, 1886.

LOWELL, MASS.:
CITIZEN NEWSPAPER CO., PRINTERS.
1886.

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CITY OF LOWELL.

IN COMMON COUNCIL, JAN. 15, 1886.

Read and sent up to the Board of Aldermen.

DAVID CHASE, *Clerk.*

IN BOARD OF ALDERMEN, JAN. 15, 1886.

Read by title and ordered on file.

SAMUEL M. CHASE, *City Clerk.*

—

CIVIL ORGANIZATION, LOWELL WATER WORKS.

From their commencement to Jan. 1, 1886.

JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Cyrus H. Latham, alderman.
William H. Anderson, councilman.
Frederick T. Greenhalge, councilman.
Albert A. Haggett, councilman.
Edwin Lamson, councilman.

1871.

Edward F. Sherman, mayor.
Albert A. Haggett, alderman.
Henry P. Perkins, councilman.
Jeremiah Crowley, councilman.
William Dolbins, councilman.

1870.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Albert A. Haggett, councilman.
Wm. Kittredge, councilman.
Wm. O. Fiske, councilman.

1872.

Josiah G. Peabody, mayor.
Alexander G. Cumnock, alderman.
Henry P. Perkins, councilman.
Nathaniel C. Sanborn, councilman.
Crawford Burnham, councilman.

WATER COMMISSIONERS.

1870-71-'72.

Levi Sprague, chairman.
Wm. E. Livingston.
Henry H. Wilder, resigned Sept. 26, 1871.
Samuel K. Hutchinson, elected to fill vacancy.

WATER BOARD.

1873.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Jonathan P. Folsom, alderman.
Nathaniel C. Sanborn, councilman.
Nathan W. Frye, councilman.

1878.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
Charles H. Harvey, councilman.

1874.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Nathaniel C. Sanborn, alderman.
Nathan W. Frye, councilman.
G. W. S. Hurd, councilman.

1879.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
Edward B. Pierce, councilman.
Robert G. Bartlett, councilman.

1875.

Geo. Runels, president, from the citizens, resigned Nov. 9, 1875.
Cyrus H. Latham, president *pro tem.*; from the citizens.
Benjamin Walker, alderman.
Albert A. Haggett, councilman.
Earl A. Thissell, councilman.

1880.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Robert Wood, alderman.
Charles C. Hutchinson, Councilman.
Edward B. Pierce, councilman.

1876.

Cyrus W. Latham pres., from the citizens.
Earl A. Thissell, from the citizens.
Albert A. Haggett, alderman.
Benj. C. Dean, councilman, resigned May, 1876.
John F. Kimball, councilman, elected to fill vacancy.
Orford R. Blood, councilman.

1881.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Robert Wood, alderman.
Charles C. Hutchinson, councilman.
Samuel Hosmer, councilman.

1877.

Cyrus H. Latham, pres., from the citizens.
Albert A. Haggett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
James W. Bennett, councilman.

1882.

Albert A. Haggett, pres., from the citizens.
Charles C. Hutchinson, from the citizens.
Thomas R. Garity, alderman.
William N. Osgood, councilman.
Frank Wood, councilman.

WATER BOARD.

1883.

Albert A. Haggett, pres. from the citizens.
Chas. C. Hutchinson, from the citizens.
George W. Fifield, alderman.¹
Edward B. Peirce, councilman.
John J. Hogan, councilman.

1885.

Albert A. Haggett, pres. from the citizens.
C. A. R. Dimon, from the citizens.
James Francis, alderman.
Alfred M. Chadwick, councilman.] . . .
Arnold S. Welch, councilman. . . .

1884.

Albert A. Haggett, pres. from the citizens.
C. A. R. Dimon, from the citizens. . .
George W. Fifield, alderman.
Edward B. Peirce, councilman.
John J. Hogan, councilman.

1886.

Walter Coburn, pres. from the citizens.
C. A. R. Dimon, from the citizens.
James Francis, alderman.
Arnold S. Welch, councilman.
Frank W. Howe, councilman.

Investigations were made at various times, by order of the City Council for the introduction of pure water into the city, viz: By Joint Special Committees consisting of the following named citizens:

1838.

**Oliver M. Whipple, alderman.
George Brownell, alderman,
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
David Dana, councilman.**

1839.

**Oliver M. Whipple, alderman.
John Clark, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
John Nesmith, councilman.**

1848.

**Jefferson Bancroft, mayor.
Oliver M. Whipple, alderman.
David Dana, alderman.
John Avery, councilman.
Otis L. Allen, councilman.
Thomas Hopkinson, councilman.
Ignatius Tyler, councilman.**

1865.


**George W. Norris, alderman.
Edward F. Watson, alderman.
Charles W. Dodge, councilman.
T. L. P. Lamson, councilman.
John Pearson, councilman.**

1866.

**Josiah G. Peabody, mayor.
Charles W. Dodge, alderman.
Joseph L. Sargent, alderman.
Benjamin Walker, councilman.
Edward C. Rice, councilman.**

WATER BOARD, 1886.

<i>President</i>	.	.	.	WALTER COBURN.	
				Term expires first Monday in May, 1887.	
				C. A. R. DIMON,	
				Term expires first Monday in May, 1886.	
				ALDERMAN JAMES FRANCIS.	
Councilman	ARNOLD S. WELCH.			Councilman	FRANK W. HOWE.
				Clerk	HORACE H. KNAPP.
<i>Superintendent of Works</i>	.	.	.	.	HORACE G. HOLDEN
<i>Foreman of Works</i>	.	.	.	.	THOMAS DOYLE.
<i>Engineer at Pumping Station</i>	.	.	.	.	JAMES P. ROBERTS.
<i>Service Clerk</i>	.	.	.	.	LEONARD T. FARRIS.
				<i>Inspectors.</i>	
	JOHN J. BANCROFT.				ANDREW J. DEVOLL.
	THOMAS E. LENNON.				WILLARD S. KNOWLTON.
				<i>Meter Inspector.</i>	
				HENRY E. SPRAGUE.	

 The Water office is open daily, from 9 A. M. to 3 P. M., and on Monday evenings, from 7 to 8 o'clock.

REPORT OF THE WATER BOARD.

OFFICE OF LOWELL WATER BOARD,
LOWELL, MASS., Jan. 12, 1886.

To the City Council of the City of Lowell:

GENTLEMEN—The Lowell Water Board in compliance with the Ordinances of the City of Lowell herewith present the Thirteenth Annual Report of the Board:

The year 1885 has been in the Water-Works department one of continued prosperity, and we are pleased to be able to report an increase of the net charges for water of nearly \$7,000 over the charges of 1884.

All departments of the Water-Works are in excellent condition, and are in charge of faithful men, who have been long in the service of the city, in this department.

For the details of work done by this department we would refer to the accompanying Reports of the Superintendent and Engineer.

This department has always been fortunate in having unanimity of action within the Board, every member taking a personal interest in the work of the department, so that a line of action, after careful consideration, being adopted, all have assisted to carry it forward to a successful result.

The first meeting of the Board for the year 1885, was held on the evening of January 12th, the board

Ward to repair the Beacon Street Reservoir at the following rates, viz.:

For Hoisting Engines per day.. .. .	\$2.00
“ Steam Derricks “ “	2.00
“ Hand “ “ “	1.00

All wheelbarrows, dirt boxes, chains, bars, picks and shovels, mortar boxes, etc , per day, \$1.00, and a commission of 15 per cent. on actual cost of labor of teams and men, for superintendence.

STATISTICS.

The total amount of water pumped during the year was 1,299,730,280 U. S. gallons, against 1,105,277,600 U. S. gallons in 1884, and the daily average pumped was 3,560,904 gallons, against 3,157,936 in 1884, an increase for the year of 194,452,680 gallons, and of 402,968 gallons in the daily average.

The quantity of coal consumed during the year for all purposes, excepting for the High Service Supply was 1,219 $\frac{8}{10}$ tons against 1042 $\frac{8}{10}$ tons in 1884. For the High Service supply the consumption during the year was 28 $\frac{8}{10}$ tons against 30 $\frac{3}{10}$ tons in 1884.

There have been 532 $\frac{9}{10}$ gallons of water raised 160 $\frac{7}{10}$ feet high for each pound of coal consumed during the year.

There are now laid 79 $\frac{1}{10}$ miles of street mains, the increase for the year having been 2 $\frac{2}{10}$ miles. The total net charges for water rates for the year after deducting all abatements, and the charges for service pipes, have been \$153,748.32 against \$145,999 93 for the year 1884, an increase for the year of \$7,748.39.

The following table will show the monthly charges for water, from the commencement of the Works to December 31st, 1885, with all abatements, and total net charges:—

FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this department for the year ending Dec. 31, 1885, is as follows, viz:

For Water Rates	\$92,565.17	
Metered water.....	63,283.81	
Total for the use of water..... ..		\$155,848.98
For service pipe and laying.....	\$1,636.70	
Meters sold.....	2,275.50	
Sundry accounts.....	3,101.61	7,013.81
Total charges for the year.....		\$162,862.79

The following statement exhibits receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the total cost and expenses of the Works by taxation:

Net cost of Water Works to Jan. 1, 1885, as per last annual report	\$2,370,294.37
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Expended during the year for Water pipes, and for laying the same, and all other items of

CONSTRUCTION.

MATERIALS FOR MAINS, SERVICES, &c. :—

Cast-iron pipe.....	\$4,094.36	
Cast-iron specials.. ..	319.96	
Wrought-iron pipe and fittings.....	776.70	
Iron castings.....	170.76	
Brass castings.....	22.12	
Lead pipe.....	1,296.17	
Lead pig.....	296.55	
Tin pig.....	21.24	
Powder, fuse, &c.,.....	76.40	
Stop and waste cocks	836.28	
Hardware.....	100.45	
Teaming pipe.....	123.08	
Lumber.....	244.56	
Freight.....	314.29	
Amounts carried forward,	\$8,692.92	\$2,370,294.37

<i>Amounts brought forward,</i>	\$8,692.92	\$2,870,294.37
Wood.....	26.00	
Tinning couplings.....	3.34	
Kyanizing boards.....	40.61	
Cement.....	1.24	
Charcoal.....	2.40	
Concrete.....	39.25	
Damage.....	1.00	
Service boxes.....	308.41	
Water gates.....	723.50	
Hydrants	668.20	
Hydrant repairs.....	5.75	
Hydrant castings.....	163.58	
Hydrant freight.....	20.24	
	<hr/>	
	\$10,696.44	

LABOR, PAY-ROLL ON ACCT. OF—

Extensions.....	\$1,969.97	
Services	1,144.89	
Piping	773.56	
Foreman.....	870.17	
	<hr/>	
	\$4,758.59	
	<hr/>	
	\$15,455.03	

MAINTENANCE.

Expended for repairs, current expenses, pump-
ing, &c., viz:—

REPAIRS.

Iron, steel, &c.,.....	\$256.76
Brass castings.....	104.01
Tools, purchased and repaired.....	90.61
Hardware.. . . .	105.72
Lumber	138.18
Leather	9.17
Teaming.....	25.43
Clay pipe.....	4.40
Cleaning conduit.....	15.55
Rubber boots.....	60.25
Brick.....	2.40
Sundries.....	139.85
Labor pay-roll.....	4,872.53
Labor.....	167.51
	<hr/>
Total repairs.....	\$5,992.37

*Amount carried forward,***\$2,370,294.37**

REPORT OF THE WATER BOARD.

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Amount brought forward,

\$2,370,294.37

CURRENT EXPENSES. Pay-roll.

Salaries.....	\$1,893.55	
Inspection.....	2,805.28	
Clerk hire.....	2,845.54	
City Engineer.....	669.55	
	<hr/>	\$8,213.92

Materials.

Printing, stationery, &c.....	396.11
Postage stamps.....	29.80
Travel and express.....	80.84
Sundries, office.....	102.65
Telephone	255.25
Analyses of Water.....	100.00
Flushing sewers.....	33.00
Rent of water office.....	75.00
Coal.....	5.50
Corn, oats, straw, &c.....	230.03
Gas.....	1.86
Sundries, pipe yard.	96.95
Horse shoeing	53.97
Repairing wagons.....	210.18
Repairing harnesses.....	68.65
Horse, wagon, sleigh and harness.....	386.00
Lumber (fence at pipe yard).....	110.54
Labor at pipe yard.....	65.58

Total current expenses.....\$10,515.83

PUMPING ACCOUNT.

Coal.....	\$5,113.69
Labor pay-roll.....	3,757.11
Labor.....	48.69
Steam indicator.....	63.00
Felting	27.51
Iron, steel, &c.....	148.16
Packing.....	26.88
Oil.....	151.38
Gas	127.12
Wood	9.89
Freight.....	1.05
Brooms	4.50
Lumber	3.41
Printing.....	7.75
Sundries.....	84.73
Soap.....	5.44

Amounts carried forward,\$9,580.31 \$2,370,294.37

Amount brought forward,

\$2,370,294.37

RESERVOIR, HIGH SERVICE.

Land, Milton Fox.....	\$2,500.00
Interest, " "	278.33
Total High Service Reservoir acct.....	\$2,778.33

RECAPITULATION.

Total construction account	\$15,455.03
" repairs.....	\$5,992.37
" Current expense.....	10,515.83
" Pumping.....	9,777.57
" Meter.....	3,326.25
" Reservoir (Beacon Street)....	14,766.27
" " (High Service)....	2,778.33
Total maintenance account.....	\$ 47,156.62
Meters purchased.....	1,418.59
Amount expended for the year exclusive of in'er st...	\$61,030.24
Interest paid during the year	111,850.00
Total expenditures for the year.....	\$175,880.24
	\$2,546,174.61

CREDITS.

Amounts received by the City Treasurer during the year for water rates, service pipes and sundries, viz:

For account of 1884.....	\$ 15,020.36
" " 1885	142 936.43

Total receipts for the year.....	\$157,956.79
Net cost of works, including interest on Water Loan to Jan. 1, 1886.....	\$2,388,217.82
Present debt of the city, by bonds and notes, on account of construction of Water Works.....	\$1,890,000.00
Total amount paid from the City Treasury to Jan. 1, 1886, by taxation on account of Water Works, in excess of receipts from Loans and water rates	\$513,217.82
Value of Water Works Sinking Funds, Jan. 1, 1886	511,557.96
	\$1,024,775.78
Net cost of Works, including interest on Water Loan to Jan. 1, 1886	\$2,388,217.82
Whole amount paid by taxation, and by appropriation for the sinking Funds, and the value of the accumulation of said Funds, Jan. 1, 1886	\$1,024,775.78
Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, Jan. 1, 1886	\$1,363,442.04

The following table will show the gross cost of the Water Works, yearly, from the commencement of the same to Jan. 1st, 1886 :

Expended in	1870	\$ 95,057.00
"	1871	624,151.66
"	1872	560,708.40
"	1873	349,717.87
"	1874	233,370.63
"	1875	275,660.78
"	1876	221,502.24
"	1877	163,814.28
"	1878	158,510.15
"	1879	150,047.82
"	1880	154,391.59
"	1881	231,171.27
"	1882	173,645.92
"	1883	179,713.23
"	1884	174,552.71
"	1885	175,880.24
		<hr/>
Gross cost of Works to Jan. 1, 1886,		\$3,921,895.79
Receipts from various sources to Jan. 1, 1886,		1,533,677.97
		<hr/>
Net cost of Works to Jan. 1, 1886,		\$2,388,217.82

The following table will show the expenditures and receipts of the Works from 1873 to 1886, exclusive of the interest on the Water Debt:

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873	\$188,376.59	\$ 57,739.48	\$180,637.11	
1874	128,105.63	80,625.66	47,479.98	
1875	170,095.78	94,908.14	75,187.64	
1876	115,012.24	98,815.54	16,196.70	
1877	53,988.72	100,826.63		\$46,837.91
1878	49,900.15	104,142.87		54,242.72
1879	42,157.82	110,185.34		68,027.52
1880	45,031.59	123,740.49		78,708.90
*1881	121,601.27	128,053.97		6,452.70
†1882	64,525.92	140,397.96		75,872.04
1883	65,673.23	152,582.99		86,909.76
1884	64,982.71	154,437.55		89,454.84
‡1885	64,030.24	157,956.79		93,926.55

* In 1881 there were expended the following extraordinary amounts :

For River crossing, 24 inch reserve line \$ 9,988.59

For High Service Water supply 57,969.39

† In 1882, High Service Water supply 10,898.59

[‡ In 1885, Beacon Street Reservoir 14,766.27

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68, \$86,770.63 and \$108,692.82.

For the report on the Sliding of the Paving at the Beacon Street Reservoir, we would refer you to the accompanying Report of the Engineer in charge.

The thanks of the citizens of Lowell and of this Board are due to Messrs. Davis and Francis, Consulting Engineers, and also to the City Engineer, Mr. Evans who devoted his best thought and talents to the work, and it reflects great credit on his ability, that all of his suggestions received the unqualified approval of the eminent Consulting Engineers.

The Pumping Station is in perfect condition, under the watchful care of our Engineer, Mr. Roberts, whose long and faithful services need no word of commendation from us.

We would recommend that in the near future, as soon as the net receipts have reached a certain point, that increased facilities for filtering be supplied, that all the water used may be filtered. This growing need, we trust, will suggest itself to future Boards.

The Ordinance Licensing Plumbers and Pipe Fitters, has during the year been made a part of the Ordinances of the City of Lowell. And the Board turn over to our successors the duty of promulgating rules and regulations which shall govern Plumbers and Pipe Fitters in their work in connection with the City Water Works.

Under the protecting care of the City Council of 1885, the Water department now occupy commodious departments on the ground floor of the Government Building supplied with a fire-proof vault, where the valuable Records of the Department may be safely kept, relieving us of constant anxiety, that in case of

fire in the building, Records representing thousands of dollars to the City, would be destroyed.

We commence another year with every prospect of continued prosperity.

Respectfully submitted,

WALTER COBURN,
CHAS. A. R. DIMON,
A. M. CHADWICK,
JAMES FRANCIS,
ARNOLD S. WELCH,

Members of the Lowell Water Board.

IN WATER BOARD, JAN. 12, 1886.

Read and accepted, and ordered to be transmitted to the City Council.

Attest:

HORACE H. KNAPP,
Clerk.

ACCOUNTS OF THE TREASURER.

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CITY TREASURER OF LOWELL IN ACCOUNT WITH LOWELL WATER WORKS.

Dr.				Cr.			
1885.				1885.			
				By payments during the year, viz :			
Jan.	To appropriation	\$	3000.00	Interest.	Salaries.	Drafts.	Refunds.
"	" Water receipts		6,692.73	\$ 3,210	\$158.33	\$2,593.44	
Feb.	" "		6,092.13	330	158.34	4,545.45	
Mar.	" "		1,794.98	300	158.33	1,769.00	
Apr.	" "		4,639.10	1,745	158.33	2,179.86	
May	" "		28,721.54	46,870	151.89	2,998.74	\$991.90
June	" "		53,033.26	5,630	158.33	7,028.21	2.75
July	" "		21,114.51	1,140	158.33	5,993.59	88.85
Aug.	" "		12,793.84	420	158.34	5,932.38	8.82
Sept.	" "		6,225.18		158.33	3,908.35	
Oct.	" "		7,499.53	1,685	158.33	10,908.37	
Nov.	" "		6,903.19	44,350	158.34	9,858.56	
Dec.	" "		3,584.12	6,170	158.33	4,420.74	
"	Overdraft		42.00				
"	Reservoir Loan		15,000.00				
				\$111,850	\$1,893.55	\$62,136.69	\$1,092.32
				Bal.	\$176,972.56	163.55	
					\$177,136.11		

THIRTEENTH ANNUAL REPORT
OF THE
City Engineer to the Water Board.

JANUARY 1, 1886.

REPORT OF THE ENGINEER.

OFFICE OF CITY ENGINEER,
LOWELL, MASS., JAN. 1, 1886.

To the Lowell Water Board:

GENTLEMEN: —The undersigned respectfully submits the Thirteenth Annual Report of the work done by the Pumping Engines at the Pumping Station, and the Records, as taken at the Beacon Street Reservoir. The calculations of the duty of the engines were made from the records kept by Mr. James P. Roberts, the engineer in charge.

All the coal used at the station has been charged to pumping, and no deduction has been made; and in the calculation of the duty nothing has been added for friction in the pump.

During the year the Morris engine has run one hundred and thirty-seven and the Worthington forty-five nights. March 24th, the Morris engine pumped 5,952,640 gallons, and April 30th the Worthington engine pumped 5,665,250 gallons, which is the largest quantity pumped during any run of twenty-four hours this year.

In the table of the running expenses of the engines the amounts will not agree with the pumping account as given in the report of the Water Board, for the reason that only the articles used during the year are included. The Morris engine having pumped eighty-four per cent. of all the water; eighty-four per cent. of the pay, cylinder and crude oil, waste, repairs on boilers, tools and sundries, in the running expenses, has been charged to the Morris engine, and the balance to the Worthington engine, this being considered a just division.

The average cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is nine dollars and twelve cents, which added to the cost of raising the same quantity into the low-service reservoir, makes the total cost of raising one million gallons into the high-service reservoir sixteen dollars and forty-one cents.

Table showing work done with Worthington High-Service Engine, 1885.

MONTHS.	No. of days Pumping.	Average number of hours Pumping per day.	Number of hours Pumping per month.	Number of strokes made per month.	Average number of strokes made per minute.	Average head, including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. of gallons of water pumped into reservoir per lb. of total coal consumed.	Coal in lbs used when pumping.
January	4	h. m. 11-37	h. m. 46-30	85,960	30.81	77.79	1,203,440	300,860	318	3,780
February	4	11-07	44-30	88,787	31.38	78.09	1,173,018	293,254	321	3,650
March	4	11-54	47-35	105,079	36.80	78.67	1,471,106	367,776	320	4,600
April	3	14-50	44-30	92,477	34.64	78.67	1,294,678	431,559	313	4,140
May	4	10-58	43-50	91,602	34.83	78.09	1,282,428	320,607	327	3,920
June	4	15-35	62-20	137,070	36.65	78 67	1,918,980	479,745	325	5,900
July	5	12-24	62-00	147,919	39.76	78.67	2,070,866	414,173	305	6,800
August ,	4	14-15	57-00	128,330	37.52	78.67	1,796,620	449,155	327	5,500
September	4	15-00	60-00	117,858	32.74	78.67	1,650,012	412,503	324	5,100
October	11	8-25	92-30	125,892	22.68	80.77	1,762,488	160,226	326	5,400
November	7	9-31	66-40	116,308	29.08	81.31	1,628,312	232,616	313	5,206
December	2	18-15	36-30	81,435	37.18	78.67	1,140,090	570,045	319	3,570
Totals and averages.	56	11-51	663-55	1,313,717	32.98	78.89	18,392,038	328,429	319	57,566

RESERVOIR, 1885, BEACON STREET.

The following table shows the average depth of water, the number of gallons, and the temperature of the water in the reservoir, and also the temperature of the air for each month. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 and 6 P. M.

MONTHS.	Depth in Feet.	Quantity in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air.
January.....	18.11	27,425,970	33.37	24.82
February	18.45	27,986,140	33.00	19.01
March.....	18 22	27,599,570	33.74	27.15
April.....	18.04	27,302,110	42.05	49.06
May.....	18.32	27,762,340	56.10	57.21
June	18.02	27,264,960	68.37	71.04
July.....	18.15	27,483,800	74.85	75.21
August.....	17.86	27,012,160	71.87	69.24
September.....	17.64	26,643,400	62.71	61.31
*October			53.58	51.80
*November.....			42.26	42.41
December	16.98	25,568,990	33.98	30.73

*Reservoir being cleaned and repaired.

Table showing the average monthly and daily consumption of water for the year 1885 :

MONTHS.	Gallons per month.	Gallons per day.
January	128,269,760	4,137,730
February	137,899,390	4,924,980
March	121,144,650	3,907,890
April	93,100,400	3,103,350
May	92,891,640	2,996,500
June	103,294,290	3,443,140
July	109,923,630	3,545,920
August	102,399,040	3,303,190
September	97,308,725	3,243,620
*October	110,604,320	3,567,880
November	93,763,433	3,125,447
December	109,976,190	3,547,620
Total and average	1,300,575,470	3,563,220

*About 4½ feet in depth, wasted from reservoir.

The following table shows the cost of coal, cost to pump one million gallons of water into the reservoir, and the total quantity pumped since the works were completed :

YEARS.	MORRIS ENGINE.			WORTHINGTON ENGINE.		
	Average cost of coal per ton.	*Cost to raise 1,000,000 galls. of water into reservoir.	Total quantity of water pumped.	Average cost of coal per ton.	*Cost to raise 1,000,000 galls. of water into reservoir.	Total quantity of water pumped.
1873	\$8.63	\$31.88	186,683,700			
1874	7.85	21.25	288,060,990			
1875	7.81	14.33	445,017,090			
1876	6.83	11.54	397,768,750	\$6.94	\$14.68	145,698,140
1877	6.43	10.71	553,887,540	6.50	13.05	41,559,530
1878	5.48	9.13	653,323,140	5.51	11.77	36,593,020
1879	4.89	8.69	652,166,530	4.92	9.87	86,863,860
1880	4.42	7.84	771,500,100	4.49	9.48	52,100,770
1881	5.27	†9.72	718,721,320	5.81	9.88	156,275,340
1882	5.24	8.73	773,749,760	5.18	9.12	186,181,970
1883	5.12	8.55	803,694,400	5.35	10.66	238,796,100
1884	4.70	7.88	931,831,360	4.84	†11.62	173,446,240
1885	4.17	7.12	1,093,415,360	3.98	8.22	206,314,920

*Not including interest on works.

†Extraordinary repairs.

It being very difficult to procure pure clay in time for the work so as not to delay the paving, and the difficulty of working it as the weather had become cold, none was used in repairing the puddle slopes. The first stone of the foundation course was laid October 22nd, and the paving on the slopes November 8th, was laid up to a height that allowed water to be pumped into the reservoir to a depth of four feet, which was increased as the paving progressed.

The paving was finished November 30th, making thirty-one working days to complete it. The plan of relaying the paving was changed and instead of having a base course laid level with the bottom, a trench was excavated five and one-fourth feet deep and at right angles to the slope.

The bed stones varied from three and one-half to five feet wide, and from twelve to eighteen inches thick, and the second course was about two and one-half feet wide and fifteen inches thick. These courses were laid in cement mortar and at right angles to the slope paving, which was laid dry upon a layer of broken stones from eight to twelve inches thick.

At the foot of the old paving on the west slope which remained in place adjoining the southwest angle a block of cement concrete three feet square and forty-six feet in length was laid to prevent it from sliding. At the foot of the north slope, at the northwest corner a block of granite masonry about three feet square and nine feet in length was laid in cement mortar.

The northeast slope paving which bulged near its center soon after the reservoir was completed has increased some during the past thirteen years, but is considered stable. During the time the basin was drawn off this slope was carefully measured and watched, and no movement was discovered. This paving will probably remain as it is, if a blind drain is laid outside the exterior slope at a depth below the bulged portion so as to intercept and carry off the water from the springs which are in the side hill above. To prevent this slope from sliding, which has started at the foot, a dry wall eight feet wide and four feet high was laid overlapping the footing course. This work was done under a contract with Luther F. Kittredge.

The other slope paving has remained as originally laid except a slight settlement at the top.

I would recommend that the waste material which is now piled up against the west embankment be used in the spring to increase the thickness of the embankment at the base, and also that the portion

opposite the gate house be considerably increased. The top of the entire embankment should be raised on the inner line so as to incline the surface toward the outer slope to prevent any drainage into the reservoir.

Respectfully submitted,

GEORGE E. EVANS, *City Engineer.*

THIRTEENTH ANNUAL REPORT
OF THE
Superintendent of Water Works,
TO THE
LOWELL WATER BOARD.

JANUARY 1, 1886.

REPORT OF THE SUPERINTENDENT.

SUPERINTENDENT'S OFFICE, CITY HALL.

LOWELL, JANUARY 1, 1886.

To the Lowell Water Board:

GENTLEMEN:—In compliance with the requirements of the City ordinance relating to the Water Works, I respectfully submit herewith the thirteenth annual report of the Superintendent of the Lowell Water works for the year ending December 31st, 1885.

The total amount of water pumped into the reservoir during the year was 1,299,766,280 gallons, an increase of 194,488,680 gallons over the amount used in 1884. This gives an average daily consumption of about 55 gallons of water for each inhabitant, and includes all the water that is used for manufacturing purposes as well as for domestic use, also for street fountains, extinguishing fires, sprinkling streets, etc. The total quantity of water sold by meter measurement amounts to 316,419,050 gallons, an increase over last year of 34,472,650 gallons.

A general inspection of the filter inlet, gallery and conduit was made May 13th by the Water Board accompanied by the City Engineer.

As there was from 6 to 12 inches of silt all through the bottom of the brick conduit and a thick coating of slime on the sides and top of both the gallery and conduit it was deemed advisable to give both the gallery and conduit a general cleaning, and in order to accomplish this in a thorough manner, a 30 inch blow off was connected to the conduit pipe on the westerly bank of Beaver Brook, and a 30 inch gate set in the main line, so that by closing this gate and opening the blow off gate, the conduit can be drawn off in a short time. July 16th the conduit was drawn off and as large a force of men as could work to advantage were set at work with hoes and rattan brooms to scrape the bottom and scrub the sides. The cleaning was done in the day time, and each night the 30 inch river gate was opened, letting the water rush through so as to carry all the sediment that had been stirred up during the day, out through the blow off

of water into the reservoir. No repairs of any account have been made on either engine. The No. 1 boiler has had a new set of wrought iron tubes, a 2½ inch return bend coil heater has been put into the flue behind the new boilers, and a sleeping apartment has been partitioned off from the engine room.

HIGH SERVICE.

Eighteen million three hundred and ninety-two thousand and thirty-eight gallons of water have been pumped into the high-service reservoir during the year, a decrease of 781,312 gallons over last year. There have been no new extensions laid on this division but 3 services in Belvidere and 2 in Centralville have been added, making a total of 119 houses, 6 stables, 2 fountains, and 30 hydrants now supplied with water from the high service system.

RESERVOIRS.

September 26th pumping was suspended preparatory to drawing off the reservoir in order to clean out whatever sediment had accumulated during the past thirteen years. There was an average depth of about 4 inches of sediment, composed principally of silt which had been pumped up from the river during freshets.

While the reservoir was being drawn down, three of the paved slopes slipped out from the bottom, necessitating the entire rebuilding of these slopes.

For a detailed statement of the accident and the repairs of the slopes, I refer you to the accompanying report of the City Engineer Mr. George E. Evans.

Pumping was resumed October 4th, the gate between the gate chamber and reservoir being closed, and the partition gate opened, so that the water went direct from the force main through the gate chamber into the distributing main.

October 5th, the water having all been drawn out of the reservoir, work was commenced preparatory to taking out and relaying the slopes which were completed December 2nd. After the slopes were finished the fences were replaced, but the winter season being so far advanced it was thought best to suspend cleaning up the grounds until spring.

After the sediment had been removed from the reservoir and the remaining slopes scraped and washed, water was again let in, and November 26th the reservoir being so near completed that it held 20 feet of water, the mains throughout the city were given a thorough blowing off, so that now the whole water system is practically as clean as when first constructed.

SERVICES.

Two hundred and fifty-four new services have been put in ; 133 old services have been changed for either lead or larger iron, and 24 services having been discontinued were cut off at the main.

Complaints regarding the filling up of the service pipes have been of frequent occurrence. Also many of the first services laid have already begun to rust through, showing conclusively that there is a limit to the durability of wrought iron pipe. This year it was thought advisable to substitute lead pipe, in consideration that Prof. Samuel Cabot of Boston had made a careful analysis of our city water, also of lead pipe which had been in use here over 12 years and reported that there could be no trouble caused by the use of it.

The amount of service pipe laid as follows :

Laid during 1885, $\frac{3}{4}$ inch wrought iron pipe.....	1,664 feet
“ “ 1 inch “ “	2,579 “
“ “ $1\frac{1}{2}$ inch “ “	32 “
“ “ 2 inch “ “	243 “
“ “ $2\frac{1}{2}$ inch “ “	56 “
“ “ 3 inch “ “	20 “
“ “ $\frac{1}{2}$ inch lead “	3,450 “
“ “ $\frac{3}{4}$ inch “ “	582 “
“ “ 1 inch “ “	345 “
<hr/>	
Total laid during 1885.....	8,971 feet
Add amount previously laid.....	258 320 feet
<hr/>	
Total amount laid.....	267,291 feet

New fences have been built around the pipe yard on Broadway and around the gate chamber grounds on Varnum avenue.

In addition to the cast iron main pipe laid there has been an additional amount of wrought iron smaller sizes as per following :

Schedule of Small Pipe Laid.

STREETS.	1 inch.	1½ inch.	Total ft.
Cabot, changed from ¾ inch		129	129
Court off Fulton street		190	190
Court off Old Meadow Road	166		166
Lowell Manf'g Co., off Market St., lead .	283		283
Meadowcroft (off in court)	147		147
Mt. Grove		245	245
Old Meadow Road		587	587
Old Meadow Road, changed from ¾ inch .		372	372
West	57		57
Total	653	1523	2176

In conclusion, I desire to express my sincere thanks to your honorable Board for the uniform kindness extended to me in the discharge of my several duties during the past year.

Respectfully submitted,

HORACE G. HOLDEN, Supt.

Low Service.—Water Pipes Laid in 1885.—Concluded.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.				
		4 in.	6 inch	8 inch	30 inch	Total.
Sutherland .	Hildreth st. and Barker ave.		855			855
Taylor . .	Across Concord river .			475½		475½
Third ave. .	N'east'ly from M'moth Road		696½			696½
Twelfth . .	Extended westerly to May		132			132
Walden . .	Westerly from Oakland av.		195			195
Ware . . .	Extended southerly .		47½			47½
Webster . .	Southerly from Tenth .	218				218
West (Ward 3)	Lincoln and London .	205				205
West Fourth .	Extended to pipe in Bridge		144			144
West Nineteenth	Extended easterly .		380			380
Blow-off . .	On pipe c'duit line at B. Bk.				52	52
	Hydrants		86			86
		1026	9191½	475½	52	10,745
Brooks st. not reported in 1882		50				50
West st. Ward 2 " " 1884.			58			58
Total in feet		1076	9249½	475½	52	10,853
Low service pipes laid previous to 1885 .						392,408
Total low service to Jan. 1, 1886 .						403,261
High service pipes laid previous to 1885 .						15,171
Total high and low service to Jan. 1, 1886						418,432
Total in miles to Jan. 1, 1886						79.25

List of Hydrants Set During the Year 1885.

STREETS.	LOCATION.
Boynton	Opposite Barker avenue, southerly side
East Merrimack	Southerly side, 38 ft. west from town line.
Humphrey	Easterly side 520 ft. northerly from Methuen street.
Ludlam	Southerly side, 400 ft. easterly from Hildreth street.
May	Westerly side 216 ft. southerly from Thirteenth street.
Methuen	Southerly side, opposite Humphrey street.
Sutherland	Northerly side 412 ft. easterly from Hildreth street.
Third avenue	Northerly side, opposite westerly line Mt. Grove street.
Bridge	Between Merrimack street and Amory street, easterly side. Taken out 3 old pattern P. H., and replaced with 3 new pattern three way P. H.
French	Between John street and Bridge street, taken out 2 old pattern P. H., and replaced with 2 new pattern three way P. H.

List of Stop Gates Set During the Year Ending Dec. 31, 1885.

pungs, 2 horse brushes, 2 hay forks, 2 manure forks, 1 wagon jack, 2 wagon wrenches, 2 canvass covers for horses, 4 harnesses, 2 tons of hay, $1\frac{1}{2}$ tons of carrots, 600 feet of lumber for gate boxes, 6 post hydrants, 6 flush hydrants, 15 second hand hydrants, 12 pairs pipe tongs, 2 stilson wrenches, 5 monkey wrenches, 3 tapping machines, 20 dippers for drinking fountains, 150 feet block tin wire, 1 30-foot extension ladder, $\frac{1}{2}$ bbl. linseed oil, 1 gallon paint for fountains, 2 ratchet cutters, 4 pipe cutters, 4 pipe vices, 20 dies, 2 ratchet die plates, 6 die plates, $1\frac{3}{4}$ inch tap, 1 inch tap, $1\frac{1}{2}$ inch tap, 4 oil cans, 125 feet block tin tubing, 1 soldering pot, 1 mould, 1 charcoal furnace, 1 naptha furnace, 3 bbl. charcoal, 5 soldering irons, 20 gate spindles, 2 gate disks, 11 hydrant spindles, 24 hydrant valves, 12 hoes, 33 hydrant packings for top, 33 hydrant packings for bottom, 34 5-inch packings for top, 34 5-inch for bottom, 10 packings for 4-inch gate, 12 packings for 6-inch gate, 6 packings for 8-inch gate, 3 packings for 12-inch gate, 1 packing for 16-inch gate, 1 map of distributing main pipes, 1 map showing stop gates, one map of Lowell, 1 map of United States. *Meters.*—1 2-inch. *Worthington Meter.*—3 1-inch, 2 $\frac{5}{8}$ -inch, 1 1-inch. *Desper Meter.*—2 $\frac{3}{4}$ inch, 6 $\frac{5}{8}$ inch, 3 1-inch. *Crown Meter.*—3 $\frac{3}{4}$ inch, 2 $\frac{3}{8}$ inch, 15 $\frac{5}{8}$ inch. *Worthington Meter Second Hand.*—3 $\frac{5}{8}$ inch Ball & Fitts, 3 $\frac{5}{8}$ inch meter, Fitts Rotary meter. *Crown.*—2 $\frac{5}{8}$ inch, 5 bottoms, 8 tops, 15 indicator covers for Worthington meter, 3 lbs. sealing wax, $\frac{1}{2}$ box crayons, $\frac{1}{2}$ box wax candles, 3 set packing patterns, 8 lbs. leather, 1 wire brush, 2 oil pans, 1 brass lantern, 1 pair cut nippers, 6 hard packings for meter, 10 valves and valve seats, 1 roll paper packing, 25 spindles for Worthington meter, 8 spindles for Desper, 2 brass lamps, 1 pair pliers, 1 leather tool bag, 2 match safes, 200 brass unions for $\frac{5}{8}$ inch meters, 25 brass nipples and unions for 1-inch meter, 14 brass nipples and unions for $1\frac{1}{2}$ inch meters, 4 brass nipples and unions for 2-inch meter, 1 5-gallon can, 2 $\frac{1}{2}$ gallon cans, 2 $\frac{1}{4}$ gallon cans, 1 seive and cover, 1 pail and 2 tanks for testing meters, 1 platform scale, 2 chairs, 1 desk, 1 portable closet, 1 clock, 5 pair pipe tongs, 2 stilson wrenches, 4 monkey wrenches, 4 screw drivers, 1 iron wood mallet, 1 claw hammer, 1 hatchet, 1 foot lathe, 1 lathe dog, 1 broom, 1 brush, 1 coal stove, 1 coal hod, 1 surface plate, 1 bit stock, 2 bits, 1 handsaw, 200 lbs. old brass, 2 rubber connections, 2 10-foot ladders, 1 $\frac{1}{2}$ inch top, $1\frac{3}{4}$ inch, 1 1-inch, 1 $1\frac{1}{2}$ inch, 1 pair snips, 2 washer cutters, 2 soldering irons, 1 2-inch anger, 1 set of numbers, 1 fore plane, 1 bench block, 1 Universal chuck, 1 counter scale, 2 small hammers, 35 out and inlet connections to Desper meter, 6 lead connections for taking out Worthington meter.

Property and Tools at Engine House.

1 vise, 1 work bench, 1 portable forge, 8 sets brasses for engine, 2 sets differential blocks, 1 piece 2-inch rope, 1 set fire irons, 1 brass hydrant, 3 axes, 11 wrenches, 3 handsaws, 2 jack screws, 12 cold chisels, 2 ratchet drills, 1 socket drill, 3 calking chisels, 1 barometer, 2 thermometers, 1 desk, 2 indicators, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crow bars, 64 feet $\frac{5}{8}$ inch chain, 16 eyebolts, 1 truck, 1 key wrench for air pump, 1 iron wheelbarrow, 1 bucksaw, 1 saw horse, 2 gas lamps, 1 high grade thermometer, 4 brass bolts $\frac{1}{2}$ inch diameter for pump valves, 5 spare pump valves, five sets spare weights for valves, 11 wrenches for Morris engine, 11 finished wrenches for Worthington engine, 3 sledge hammers, 10 drills assorted sizes, 1 bit stock, 5 bits, 1 25-foot ladder, 1 20-foot, 18-foot, 1 pair steps, 1 hoe, 2 racks, 1 small die plate, 1 fore plane, 6 monkey wrenches, 100 feet 2 inch rope, 4 chisel bars, 6 small taps, 4 finished socket wrenches for Worthington engine, 3 14-quart iron pails, 4 hand hammers, 2 grind stones, 1 anvil, 7 pairs gas tongs, 1 wrench, 11 finished wrenches, 1 clock, 1 set Walworth's solid dies from $\frac{1}{4}$ inch to 2-inch right and left, 2 die stocks and bushings, 2 sets 2 shive blocks, 3 pieces $\frac{5}{8}$ inch chain, 1 24-inch elbow for Worthington force main, 1 $2\frac{1}{4}$ ratchet wrench for 30-inch gate river crossing, 1 scythe, 1 snath, 7 chairs, 1 desk, 1 table.

Tools at Reservoir.

1 iron tooth rake, 1 hay fork, 3 shovels, 1 ax, 1 piece 1-inch rope, 2 hoes, 1 scythe, 1 snath, 1 grass hook, 8 wheelbarrows, 3 thermometers, 1 snow shovel, 1 stop gate wrench, 1 sidewalk wrench, 1000 feet second hand lumber, 2 spare screens, 20 lbs. nails, 1 coal stove, 1 bracket lamp, 1 lantern, 1 pick, 1 ice chisel.

Tools at Filter Inlet.

2 iron tooth rakes, 11 shovels, 1 rammer, 1 ax, 2 ice chisels. 1 stop gate wrench, 1 nail hammer, 1 pick, two brooms, 1 wheelbarrow.

Property in Water Board and Superintendent's Office.

12 chairs, 4 high stools, letter press, 7 desks with drawers, 3 standing desks, 2 office tables, 1 bookcase, 1 book rack, 1 bill cabinet, 6 inkstands, 1 clock, 1 glass mug, 3 waste baskets, 3 spittoons, 4 wrenches, 1 pick, 1 map of water distributing pipes, 2 mats, 1 lantern, water gauge, 1 apparatus for gates, 1 screw driver, 1 safe, 1 key rack, 1 atlas of Lowell, 1 black walnut bookcase, 1 instrument for testing capacity of engines.

SUMMARY OF STATISTICS,

AS SUGGESTED BY THE NEW ENGLAND WATER WORKS ASSOCIATION.

Lowell Water Works, Lowell, Mass.

Population in 1885, 64,051

Constructed in 1872 ; owned by the City of Lowell.

Source of supply is Merrimack River.

Mode of supply is by pumping and consists of one Morris pump and one Worthington pump, of 5,000,000 gallons capacity each.

The kind of fuel used is Powelton Bituminous coal.

Cost of coal is \$4.17 per ton of 2240 lbs.

	MORRIS PUMP.	WORTHINGTON PUMP.
Total coal consumed . . .	1,961,240 lbs.	480,180 lbs.
Total water pumped	1,093,415,360 gals	206,314,920 gals.
Average head pumped against .	162.3 ft.	160.76 ft.
No. of gals. pumped per lb. of coal	558 gals.	430 gals.
Duty	75,409,571 "	57,564,938 "
Cost of raising per million gals.	\$7.12	\$8.22

Financial.

RECEIPTS.	EXPENDITURES.
Water rates \$151,956.79	Construction . . . \$ 15,455.03
Services, meters, etc. . . 6,000.00	Maintenance . . . 47,156.62
Appropriation 3,000.00	Meters 1,418.59
Loan 15,000.00	Interest 111,850.00
Total \$175,956.79	\$175,880.24

SUMMARY OF STATISTICS.

CONSUMPTION.

Total number of gallons consumed for the year.....	1,299,766,280
Average daily consumption.....	3,561.000
Gallons per inhabitant.....	55.

DISTRIBUTION.

Cast iron pipe is used from 4 inches to 30 inches diameter :

Extended in 1885.....	10,853 ft.
Total in use.....	79.25 miles.
Hydrants in use.....	760
Stop gates.....	552
Blow offs.....	13
Greatest pressure	70 lbs.
Number of services in use.....	6913
Number of meters in use.....	1421

Analyses of Lowell City Water, made by S. Cabot, Chemist, July 10th, 1885.

WATERS.					
	AMMONIA.		NITROGEN AS		
	Free.	Alb'd.	Chlorine.	Nitrates.	Solids.
Lowell City Water, . C.	0.03	0.13	4.107	2.0617	2.740
Gallery, . . G.	0.14	0.105	4.107	Traces.	3.615
River, . . R.	0.05	0.14	3.422	Traces.	3.324
Cochituate, .	0.027	0.27	6.844	0.0741	7.581
Parts per million.					Grains per gal.

SEDIMENTS.				
	AMMONIA.		Total Solids.	Volatile Matter.
	Free.	Alb'd.		
Conduit Bottom, . C. B.	17.32	119.50	65.95	4.266
Conduit Sides, . C. S.	92.00	177.50	17.10	0.296
River Mud, . . R. M.	33.33	165.50	57.29	1.787
Gallery Sides, . G. S.	12.00	137.50	6.32	1.081
Gallery Bottom, . G. B.	6.66	15.50	3.84	0.258
Parts per million.			Parts per hundred.	

SAME CALCULATED ON MILLION PARTS SOLIDS.			
	AMMONIA.		
	Free.	Alb'd.	
Conduit Bottom, . . C. B.	26.26	181.19	
Conduit Sides, . . C. S.	538.01	1038.01	
River Mud, . . R. M.	58.17	288.88	
Gallery Sides, . . G. S.	189.87	2174.63	
Gallery Bottom, . G. B.	173. 44	403.64	

7.54
FOURTEENTH
ANNUAL REPORT
OF THE
Lowell Water Board
TO THE
CITY COUNCIL,

COMPANIED BY THE REPORTS OF THE CITY ENGINEER
AND OF THE SUPERINTENDENT OF WATER WORKS,
TO THE WATER BOARD.

JANUARY 10th, 1887.

LOWELL, MASS.:
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1887.

14.50

CITY OF LOWELL.

IN WATER BOARD, January 10th, 1887.

Read and accepted and ordered to be transmitted to the City Council.

Attest: ANDREW J. DEVOLL, *Clerk.*

IN BOARD OF ALDERMEN, January 17th, 1887.

Read and ordered on file. Sent down.

DAVID W. O'BRIEN, *City Clerk.*

IN COMMON COUNCIL, January 17th, 1887.

Received, read, and ordered on file in concurrence.

DAVID CHASE, *Clerk.*

CIVIL ORGANIZATION, LOWELL WATER WORKS.

. From their commencement to Jan. 1, 1887.

JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Cyrus H. Latham, alderman.
William H. Anderson, councilman.
Frederick T. Greenhalge, councilman.
Albert A. Haggett, councilman.
Edwin Lamson, councilman.

1871.

Edward P. Sherman, mayor.
Albert A. Haggett, alderman.
Henry P. Perkins, councilman.
Jeremiah Crowley, councilman.
William Dobbins, councilman.

1870.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Albert A. Haggett, councilman.
Wm. Kittredge, councilman.
Wm. O. Fiske, councilman.

1872.

Josiah G. Peabody, mayor.
Alexander G. Cumnock, alderman.
Henry P. Perkins, councilman.
Nathaniel C. Sanborn, councilman.
Crawford Burnham, councilman.

WATER COMMISSIONERS.

1870-'71-'72.

Levi Sprague, chairman.
Wm. E. Livingston.
Henry H. Wilder, resigned Sept. 26, 1871.
Samuel K. Hutchinson, elected to fill vacancy.

WATER BOARD.

1873.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Jonathan P. Folsom, alderman.
Nathaniel C. Sanborn, councilman.
Nathan W. Frye, councilman.

1878.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
Charles H. Harvey, councilman.

1874.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Nathaniel C. Sanborn, alderman.
Nathan W. Frye, councilman.
G. W. S. Hurd, councilman.

1879.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
Edward B. Pierce, councilman.
Robert G. Bartlett, councilman.

1875.

Geo. Runels, president, from the citizens, resigned Nov. 9, 1875.
Cyrus H. Latham, president *pro tem.*: from the citizens.
Benjamin Walker, alderman.
Albert A. Haggett, councilman.
Earl A. Thissell, councilman.

1880.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Robert Wood, alderman.
Charles C. Hutchinson, councilman.
Edward B. Pierce, councilman.

1876.

Cyrus W. Latham, pres., from the citizens.
Earl A. Thissell, from the citizens.
Albert A. Haggett, alderman.
Benj. C. Dean, councilman, resigned May, 1876.
John F. Kimball, councilman, elected to fill vacancy.
Orford R. Blood, councilman.

1881.

Albert A. Haggett, pres., from the citizens.
James W. Bennett, from the citizens.
Robert Wood, alderman.
Charles C. Hutchinson, councilman.
Samuel Hosmer, councilman.

1877.

Cyrus H. Latham, pres., from the citizens.
Albert A. Haggett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
James W. Bennett, councilman.

1882.

Albert A. Haggett, pres., from the citizens.
Charles C. Hutchinson, from the citizens.
Thomas R. Garity, alderman.
William N. Osgood, councilman.
Frank Wood, councilman.

WATER BOARD.

1883.

Albert A. Haggett, pres., from the citizens.
Charles C. Hutchinson, from the citizens.
George W. Fifield, alderman.
Edward B. Pierce, councilman.
John J. Hogan, councilman.

1884.

Albert A. Haggett, pres., from the citizens.
C. A. R. Dimon, from the citizens.
George W. Fifield, alderman.
Edward B. Pierce, councilman.
John J. Hogan, councilman.

1885.

Albert A. Haggett, pres., from the citizens,
C. A. R. Dimon, from the citizens.
James Francis, alderman.
Alfred M. Chadwick, councilman.
Arnold S. Welch, councilman.

1886.

Walter Coburn, pres., from the citizens.
C. A. R. Dimon, from the citizens.
James Francis, alderman.
Arnold S. Welch, councilman.
Frank S. Howe, councilman.

1887.

Walter Coburn, pres., from the citizens.
C. A. R. Dimon, from the citizens.
James Francis, alderman.
Arnold S. Welch, councilman.
Frank W. Howe, councilman.

Investigations were made at various times, by order of the City Council for the introduction of pure water into the city, viz.: By Joint Special Committee consisting of the following named citizens :

1838.

Oliver M. Whipple, alderman.
George Brownell, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.
John Clark, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
John Nesmith, councilman,

1848.

Jefferson Bancroft, mayor.
Oliver M. Whipple, alderman.
David Dana, alderman.
John Avery, councilman.
Otis L. Allen, councilman.
Thomas Hopkinson, councilman.
Ignatius Tyler, councilman.

1865.

George W. Norris, alderman.
Edward F. Watson, alderman.
Charles W. Dodge, councilman.
T. L. P. Lamson, councilman
John Pearson, councilman.

1866.

Josiah G. Abbott, mayor.
Charles W. Dodge, alderman.
Joseph L. Sargent, alderman.
Benjamin Walker, councilman.
Edward C. Rice, councilman.

WATER BOARD, 1887.

President . . . **WALTER COBURN.**

Term expires first Monday in May, 1887.

C. A. R. DIMON,

Term expires first Monday in May, 1888.

ALDERMAN JAMES FRANCIS.

Councilman ARNOLD S. WELCH.

Councilman FRANK W. HOWE.

Clerk . . . **ANDREW J. DEVOLL.**

Superintendent of Works . . . **HORACE G. HOLDEN.**

Foreman of Works . . . **THOMAS DOYLE.**

Engineer at Pumping Station . . . **JAMES P. ROBERTS.**

Service Clerk . . . **LEONARD T. FARRIS.**

Inspectors.

JOHN J. BANCROFT.

THOMAS E. LENNON.

WILLARD S. KNOWLTON.

HENRY E. SPRAGUE.

Meter Inspector.

ROBERT GARDNER.

☞ The Water office is open daily, from 9 A. M. to 3 P. M., and on Monday evenings, from 7 to 8 o'clock.

REPORT OF THE WATER BOARD.

OFFICE OF THE LOWELL WATER BOARD,
LOWELL, MASS., JAN. 10, 1887.

To the City Council of the City of Lowell:

GENTLEMEN—The Lowell Water Board in accordance with the Ordinances of the City of Lowell herewith presents the Fourteenth Annual Report of the Board:

The year 1886, like its predecessor, shows a continued increase in net charges for water used, and the Department has reached a point where it is self-sustaining. The increase over the preceding year is \$9,903.43, leaving us a balance of \$4000 over all expenses. The dwelling houses of the Engineer and of the man in charge at the Beacon Street Reservoir have been put in thorough repair at a cost of some \$800, and the expense charged to maintenance. The Works are as nearly completed as they ever will be, as extensions and improvements will be necessary every year, to a certain extent.

The Department in all its branches is in excellent condition.

For details of the workings of the Department, we would refer you to the Report of the Superintendent and Report of the Engineer accompanying.

an increased daily average over the year 1885, in the Low Service, of 338,834 U. S. gallons.

1392~~4888~~ tons of coal have been used during the year, 31 1-2 tons of which were used for the High Service engine; 245 tons for the Worthington engine; 1,107 1-4 tons for the Morris engine.

There have been 321~~78~~⁴⁷ gallons of water raised 164 feet high for each pound of coal consumed by the High Service engine, 432~~78~~⁴⁷ gallons raised 164 feet high for each pound of coal consumed by the Worthington engine, and 551~~78~~⁸⁸ gallons raised 164 feet high for each pound of coal consumed by the Morris engine. These remarkable results show the perfect condition in which the property of the city is kept at the Pumping Station.

The result of the year's work at the Pumping Station is gratifying to the Board, and to every citizen interested in the Department. The cost of pumping 1,000,000 gallons has been reduced from \$7.12 in 1885, to \$6.52 in 1886, by the Morris engine, and from \$8.22 in 1885, to \$7.53 in 1886, by the Worthington engine.

This is the lowest cost ever reached by this Department, and our Engineer, Mr. James P. Roberts, may feel a justifiable pride in the results attained.

The total net charges for water-rates for the year, after deducting all abatements and charges for service pipes, have been \$163,651.75, against \$153,748.32 for the year 1885, an increase for the year of \$9,903.43. Total number of water-takers, 14,710.

The following table will show the monthly charges for water from the commencement of the Works to Dec. 31, 1886, with all abatements and total net charges:

FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this Department during the year ending Dec. 31, 1886, is as follows, viz:

For Water Rates.....	\$96,539.37	
Metered water.....	68,740.41	
		<hr/>
Total for the use of water.....		\$165,279.78
For service pipe and laying.....	\$1,718.48	
Meters sold.....	1,936.00	
Sundry accounts.....	4,841.44	8,495.92
		<hr/>
Total charges for the year.....		\$173,775.70

The following statement exhibits receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the total cost and expenses of the Works by taxation:

Net cost of Water Works to Jan. 1, 1886, as per last annual report.....	\$2,388,217.82
Expended during the year for Water pipes, and for laying the same, and all other items of	

CONSTRUCTION.

MATERIALS FOR MAINS, SERVICES, &c. :—

Cast-iron pipe.....	\$5,676.48	
Cast-iron specials.....	305.06	
Wrought-iron pipe and fittings.....	200.23	
Iron castings.....	278.47	
Brass castings.....	15.22	
Lead pipe.....	1,257.00	
Lead pig.....	428.72	
Powder, fuse, &c.....	34.60	
Stop and waste cocks.....	551.00	
Hardware.....	69.99	
Teaming pipe.....	121.14	
Freight.....	371.16	
Tin pig.....	27.50	
Repairing tapping machine.....	26.00	
		<hr/>
<i>Amounts carried forward,</i>	\$9,353.57	\$2,388,217.82

REPORT OF THE WATER BOARD.

13

<i>Amounts brought forward,</i>	\$7,166.00	\$2,388,217.82
Repairs of Pumping Station.....	1,866.93	
of Engineer's house.....	410 00	
on trusses under Concord River Bridge.....	101.00	
Total repairs.....	\$9,543.93	

CURRENT EXPENSES. Pay-roll.		
Labor	\$ 48.75	
Salaries.....	1 900.00	
Inspection.....	3 160.32	
Clerk hire.....	3,264.47	
City Engineer.....	406.00	
	<hr/>	\$8,779.54

Materials.		
exchange of horse.....	100.00	
ionery, &c.....	519.42	
.....	49.10	
.....	39.50	
.....	47.70	
Telephone	214.12	
Exchange in sleighs	50 00	
.....	6.75	
Corn, oats, straw, &c.....	186.52	
Gas	2 18	
Sundries, pipe yard.....	14 99	
Horse shoeing.....	73.55	
Repairing wagons.....	80 22	
Repairing harnesses.....	26 15	
.....	715.50	
.....	356.61	
.....	273 94	
.....	75.00	
Exchange of carriage.....	95.50	
Total current expenses.....	\$11,706.29	

PUMPING ACCOUNT.		
Coal	\$4,924.76	
Labor pay-roll.....	3,946 81	
Iron, steel, &c.....	25.39	
Oil.....	98.72	
Gas	124 34	
Wood	30.94	
Freight.....	63	
Fuel	11.01	

<i>Amounts carried forward,</i>	\$9,157.60	\$2,388,217.82
---------------------------------	------------	----------------

<i>Amount brought forward.</i>		\$2,388,217.82
Amount expended for the year exclusive of interest..	\$ 51,808.52	
Interest paid during the year.....	115,535.00	
	<hr/>	\$167,343.52
Total expenditures for the year.....		<hr/> \$2,555,561.34

CREDITS.

Amounts received by the City Treasurer during the year for water rates, service pipes and sundries, viz:		
For account of 1885.....	\$ 15,421.71	
“ “ 1886.....	153,335.82	
	<hr/>	
Total receipts for the year.....		\$168,757.53
		<hr/>
Net cost of works, including interest on Water Loan to Jan. 1, 1887.....		\$2,386,803.81
Present debt of the city, by bonds and notes, on account of construction of Water Works..		\$1,837,000.00
		<hr/>
Total amount paid from the City Treasury to Jan. 1, 1887, by taxation on account of Water Works, in excess of receipts from Loans and water rates.....		\$549,803.81
Value of Water Works Sinking Fund, Jan. 1, 1887.		517,994.42
		<hr/>
		\$1,067,798.23
		<hr/>
Net cost of Works, including interest on Water Loan to Jan. 1, 1887.....		\$2,386,803.81
Whole amount paid by taxation, and by appropriation for the Sinking Funds, and the value of the accumulation of said Funds, Jan. 1, 1887.....		\$1,067,798.23
		<hr/>
Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, Jan. 1, 1887.....		\$1,319,005.58
		<hr/>

The following table will show the gross cost of the Water Works, yearly, from the commencement of the same to Jan. 1st, 1887 :

Expended in 1870	\$ 95,057.00
“ 1871	624,151.66
“ 1872	560,708.40
“ 1873	349,717.87
“ 1874	233,370.63
“ 1875	275,660.78
“ 1876	221,502.24
“ 1877	163,814.28
“ 1878	158,510.15
“ 1879	150,047.82
“ 1880	154,391.59
“ 1881	231,171.27
“ 1882	173,645.92
“ 1883	179,713.23
“ 1884	174,552.71
“ 1885	175,880.24
“ 1886	167,343.52
<hr/>	
Gross cost of Works to Jan. 1, 1887.....	\$4,089,239.31
Receipts from various sources to Jan. 1, 1887.....	1,702,435.50
<hr/>	
Net cost of Works to Jan. 1, 1887.....	\$2,386,803.81

The following table will show the expenditures and receipts of the Works from 1873 to 1887, exclusive of the interest on the Water Debt;

	Expenditures.	Recelpts.	Expenditures in excess of recelpts.	Receipts in excess of expenditures.
1873	\$188,376.59	\$ 57,739.48	\$130,637.11	
1874	128,108.63	80,625.66	47,479.98	
1875	170,095 78	94,908.14	75,187.64	
1876	115,012.24	98,815.54	16,196.70	
1877	58,988 72	100,825.63		\$46,837.91
1878	49,900.15	104,142.87		54,242.72
1879	42,157.82	110,185 84		68,027.52
1880	45,031.59	123 740.49		78,708.90
*1881	121,601.27	128,053.97		6,452.70
†1882	64,525.92	140,397.96		75,872.04
1883	65,673.23	152,582.99		86,909.76
1884	64,982.71	154,437.55		89,454.84
‡1885	64,030.24	157,956.79		93,926.55
1886	51,808.52	168,757.53		116,949.01

*In 1881 there were expended the following extraordinary amounts :

For river crossing, 24-inch reserve line.....\$ 9,988.59

For high service water supply..... 57,969.39

†In 1882, high service water supply..... 10,898.59

‡In 1885, Beacon street reservoir..... 14,766.27

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68, \$86,770.63 and \$108,692.82.

had anticipated. For the City to receive the full benefits of the Ordinance, there should be appointed an Inspector of Plumbing and Piping, to enforce its provisions.

Respectfully submitted,

WALTER COBURN,
CHAS. A. R. DIMON,
JAMES FRANCIS,
ARNOLD S. WELCH,
FRANK W. HOWE,

Members of the Lowell Water Board.

IN WATER BOARD, Jan. 10, 1887.

Read and accepted, and ordered to be transmitted to the City Council.

Attest:

ANDREW J. DEVOLL,
Clerk.

FOURTEENTH ANNUAL REPORT
OF THE
City Engineer to the Water Board.

JANUARY 1, 1887.

Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1886.

MON. HS.	No. of Ave. No.		No. of hours Pumping per month.	No. of strokes made per month.	Ave. No. of strokes made per minute.	No. Ave. head		Quantity Pumped per month in U. S. gallons.	Ave. quantity Pumped per day in U. S. gallons.		No. gals. of water raised in reservoir per lb. of total coal consumed.	Duty in lbs. 1 foot high, with 100 lbs. coal used in pumping only, no deduction for ashes or clinkers.	Duty on total coal consumed
	days of Pumping.	hours Pumping per day.				including friction	in feet. U. S. gallons.						
January	8	21-25	64-15	42,199	10.95	165.88	13,081,690	4,360,568			426	69,825,097	58,907,812
February	6	22-35	135-30	92,275	11.35	165.78	28,605,250	4,767,542			437	70,953,881	60,337,885
March	9	16-37	149-35	73,425	8.18	169.21	22,761,750	2,529,083			414	66,182,542	58,360,963
April													
May	11	17-22	191-00	150,929	13.17	163.55	46,787,990	4,253,454			433	70,702,034	59,049,285
June													
July	7	18-59	132-55	105,722	13.26	164.58	32,773,820	4,681,974			425	69,052,051	58,229,137
August													
September													
October	10	14-03	140-30	123,872	14.69	164.38	38,400,320	3,840,032			444	72,063,847	60,886,863
November	15	11-33	173-10	119,554	11.51	166.41	37,061,740	2,470,783			435	70,506,841	60,328,032
December													
Totals and Averages.	61	16-11	986-55	707,976	11.96	165.68	219,472,560	3,597,911			432	70,262,624	59,654,078

MONTHS.	No. of days Pump ing.	Average number of hours pumping per day.	Number of hours Pumping per month.	Number of strokes made per month.	Average number of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. Gallons.	No. of gallons of water pumped into reservoir per lb. of total coal consumed.	Coal in lbs. used when pumping.
January,	4	12-45	51-00	134,174	43.85	78.39	1,878,436	469,609	318	5,900
February,	3	13-10	39-30	97,531	41.15	78.27	1,365,434	455,145	307	4,450
March,	5	10-03	50-15	131,501	43.62	78.90	1,841,014	368,203	321	5,730
April,	3	11-20	34-00	77,364	37.92	78.67	1,083,096	361,032	308	3,510
May,	4	11-15	45-00	101,786	37.70	78.67	1,425,004	356,251	351	4,060
June,	4	13-08	52-30	121,691	38.63	78.67	1,703,674	425,918	328	5,200
July,	6	15-30	93-00	176,186	31.57	79.06	2,466,604	411,101	320	7,700
August,	5	11-06	55-30	135,087	40.57	78.67	1,891,218	378,244	324	5,840
September,	4	10-56	43-45	103,241	39.33	78.67	1,445,374	361,343	316	4,570
October,	5	11-24	57-00	121,172	35.43	78.20	1,696,408	339,282	320	5,300
November,	4	10-15	41-00	89,799	36.50	77.51	1,257,186	314,297	314	4,000
December,	5	14-12	71-00	157,091	36.88	78.67	2,199,274	439,855	323	6,800
Totals and Averages,	52	12-11	633-30	1,446,623	38.06	78.53	20,252,722	389,475	321	63,060

RESERVOIR, BEACON STREET, 1886.

MONTHS.	Depth in Feet.	Quantity in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air. °
January	18.17	27,449,500	32.81	24.39
February	17.56	26,451,600	32.03	25.02
March	17.76	26,784,400	33.07	33.54
April	17.75	26,766,500	45.08	52.05
May	17.91	27,020,400	57.77	*
June	17.68	26,650,100	65.09	*
July	17.73	26,726,800	71.40	*
August	17.57	26,459,800	71.36	*
September	18.09	27,329,700	67.23	58.92
October	17.96	27,101,400	54.57	50.33
November	18.31	27,684,000	41.78	41.47
December	17.82	26,870,800	32.30	27.04

* Temperature not taken.

Table showing the average monthly and daily consumption of water for the year 1886 :

MONTHS.	Gallons per Month.	Gallons per Day.
January	140,355,850	4,527,610
February	137,981,300	4,927,900
March	130,620,660	4,213,570
April	104,717,750	3,490,590
May	105,907,730	3,416,380
June	117,115,710	3,903,860
July	126,609,130	4,084,170
August	121,600,750	3,922,610
September	110,809,550	3,693,650
October	106,653,880	3,440,450
November	105,500,410	3,516,680
December	136,668,210	4,408,650
Total and average	1,444,540,930	3,957,650

Respectfully submitted,

GEORGE E. EVANS, *City Engineer.*

FOURTEENTH ANNUAL REPORT
OF THE
Superintendent of Water Works,
TO THE
LOWELL WATER BOARD.

JANUARY 1, 1887.

REPORT OF THE SUPERINTENDENT.

SUPERINTENDENT'S OFFICE, CITY HALL,

LOWELL, JANUARY 1st, 1887.

To the Lowell Water Board:

GENTLEMEN:—In compliance with the requirements of the City Ordinance relating to the Water Works, I respectfully submit herewith the Fourteenth Annual Report of the Superintendent of the Lowell Water Works, for the year ending December 31st, 1886.

The total amount of water pumped into the reservoir during the year was 1,441,622,640 gallons being an increase of 141,856,360 gallons over the amount pumped in 1885, and assuming the number of water users to be 65,000 will give an average daily consumption of about 60 gallons of water for each consumer. This of course includes all the water used for every purpose, such as domestic use, manufacturing, and for extinguishing fires, also water for steam boilers, drinking fountains, sprinkling streets, etc. The total quantity sold by meter measurement amounts to 326,999,950 gallons, an increase over last year of 10,580,900 gallons. The works are all in good condition. All needed repairs have been made together with many improvements.

FILTER GALLERY AND CONDUIT.

An inspection of the filter gallery showed that but a slight amount of sediment had collected on the bottom, while the sides and top were clean and in good condition.

The conduit has been blown off three times this season, in order to carry off the sediment which accumulates on the bottom after every freshet in the river. No repairs have been made on either the gallery or conduit this year.

PUMPING STATION.

The Morris engine has pumped 1,222,150,080 gallons and the Worthington has pumped 219,472,560 gallons of water into the reservoir. No repairs of any account have been made on either of

Number and Kind of Services Changed During the Year Ending Dec. 31, 1886.**Schedule of Small Pipe Laid.**

STREETS.	1 inch.	Total feet.
Court off Coburn Street	148	148 feet.
Stanley Avenue	108	108 "
South Hastings Street	22	22 "
Total	278	278 feet.

METERS.

There are now in use 1461, an increase over last year 40 ; meters set during the year, 60 ; meters taken out and repaired, 293 ; meters taken out and others set in their places, 43 ; Worthington meters taken out, cleaned and repaired, 80 ; Desper meters repaired at Worcester, 89 ; Desper meters repaired at Pumping Station, 80 ; meters worn out and replaced by others, 13 ; meters destroyed by freezing, 16 ; meters discontinued, 15.

repaired. A pipe drinking fountain has been set on Branch street near the Franklin school house. The stone troughs at Middlesex Village and on Bridge street in Centralville, have been removed and changed for pipe fountains, and the stone trough in Liberty square has been replaced by a large circular fountain made by the Mott Iron Works of New York.

CONCLUSION.

In closing this report I desire to extend to the President and members of the Water Board my sincere thanks for their uniform courtesy and co-operation in the discharge of the duties of my position.

Respectfully submitted,

HORACE G. HOLDEN, Supt.

Low Service.—List of Stop Gates Set During the Year 1886.

STREETS.	LOCATION.	4in.	6in.	12in.
Baldwin	19 ft. w'ly from e'ly line Baldwin St., 16 ft. n'ly from s'ly line Middlesex St.		1	
Bridge	22.8 ft. e'ly from w'ly line Bridge St., ft. s'ly from n'ly line W. Sixth St.			1
Chester	16.3 ft. w'ly from e'ly line Chester St., ft. n'ly from n'ly line Westford St.		1	
High	19 ft. e'ly from w'ly line High St., 2 ft. n'ly from n'ly line Rogers St.		1	
Lundberg	About 13 ft. n'ly from s'ly line Lundberg St., 1.8 feet e'ly from e'ly line Gorham St.		1	
Pleasant (Ward 3) .	32.5 ft. w'ly from e'ly line Pleasant St., 27 ft. s'ly from s'ly line W. Sixth St.		1	
Rockdale Ave. . .	5 ft. east of west line Rockdale Ave., on s'ly line Bowers St.	1		
Thorndike st. (Thorndike M'fg Co., fire service.)	5.7 ft. east of w'ly line Thorndike St., 2 ft. n'ly of w'ly wall, new mill.		1	
Front street, blow off.	14 ft. east of east line Front St., about 16 ft. south of north line Front St.		1	

and bushings, 2 sets, 2 sheave blocks, 3 pieces $\frac{1}{2}$ inch chain, 1 24 inch elbow for Worthington force main, 1 $2\frac{1}{4}$ ratchet wrench for 30 inch gate river crossing, 1 scythe, 1 snath, 7 chairs, 1 desk, 1 table, 2 engine lathes, 1 speed lathe, 1 upright drill, 31 turning tools, 1 12 inch chuck, 1 6 inch chuck, 1 No. 3 drill chuck, 1 No. 2 drill chuck 3 reamers Desper meters, 3 small reamers, 2 small taps, 16 twist drills, 4 lanterns.

Property at Reservoir.

1 iron tooth rake, 1 hay fork, 3 shovels, 2 long handle shovels, 1 ax, 1 piece 1 inch rope, 1 scythe, snath, 1 grass hook, 10 wheelbarrows, 3 thermometers, 1 stop gate wrench, 1 sidewalk wrench, 1 coal stove, 2 lanterns, 1 ice chisel, 1 nail hammer, 1 saw, 1 carpenter's square, 2 hoes, 1 piece rubber hose, 2 chairs, 1 sectional ladder, 1 dwelling house, 1 stable.

Tools and Property at Filter Inlet.

2 iron tooth rakes, 11 shovels, 1 rammer, 1 ax, 2 ice chisels, 1 stop gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow, 1 boat, 1 set of oars.

SUMMARY OF STATISTICS.

REPORT OF 1886.

IN ACCORDANCE OF SUGGESTIONS ADOPTED BY THE NEW ENGLAND WATER
WORKS ASSOCIATION.

Lowell Water Works, Lowell, Mass.

Population by census of 1885, 64,051.

Date of construction, 1870 to 1872, inclusive. Owned by the City of Lowell.

The source of supply is from Merrimack River.

The mode of supply is by pumping and consists of one Morris pump, and one Worthington pump, of 5,000,000 gallons daily capacity each.

The kind of coal used is Maryland Co.'s Cumberland.

Cost of coal is \$4.65 per ton of 2240 lbs.

	MORRIS.	WORTHINGTON.
Coal consumed for the year in pounds	2,214,550	508,000
Total pumping in gallons . . .	1,222,150,080	219,472,560
Average head including friction in feet	164.08	165.68
No. of gallons pumped per lbs. of coal	552	432
Duty on total coal consumed, no deduction for anything . . .	75,465,444	59,654,078
Cost of pumping figured on pump- ing station expenses, viz: . .	\$9,618.52	
Per million gallons into reservoir	6.52	\$7.53
Per million gallons one foot high	03. ⁹⁷ / ₁₀₀	04. ⁵⁶ / ₁₀₀

FIFTEENTH
ANNUAL REPORT
OF THE
LOWELL WATER BOARD,
TO THE
CITY COUNCIL,

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER,
AND OF THE SUPERINTENDENT OF WATER WORKS,
TO THE WATER BOARD.

JANUARY 10th, 1888.

LOWELL, MASS.:
DAILY NEWS COMPANY, PRINTERS, 76 MERRIMACK STREET,
1888.

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CITY OF LOWELL.

IN WATER BOARD, January 10th, 1888.

Read and accepted and ordered to be transmitted to the City Council.

Attest:

HORACE H. KNAPP, *Clerk.*

IN BOARD OF ALDERMEN, January 24th, 1888.

Ordered on file. Sent down.

GIRARD P. DADMAN, *City Clerk.*

IN COMMON COUNCIL, January 24th, 1888.

Received and ordered on file in concurrence.

DAVID CHASE, *Clerk.*

CIVIL ORGANIZATION, LOWELL WATER WORKS.

From their Commencement to January 1, 1887.

JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Cyrus H. Latham, alderman.
William H. Anderson, councilman.
Frederic T. Greenhalge, councilman.
Albert A. Haggett, councilman.
Edwin Lamson, councilman.

1870.

Jonathan P. Folsom, mayor.
Charles A. Stott, alderman.
Albert A. Haggett, councilman.
Wm. Kittredge, councilman.
Wm. O. Fiske, councilman.

1871.

Edward F. Sherman, mayor.
Albert A. Haggett, alderman.
Henry P. Perkins, councilman.
Jeremiah Crowley, councilman.
William Dobbins, councilman.

1872.

Josiah G. Peabody, mayor.
Alexander G. Cumnock, alderman.
Henry P. Perkins, councilman.
Nathaniel C. Sanborn, councilman.
Crawford Burnham, councilman.

WATER COMMISSIONERS.

1870-71-72.

Levi Sprague, chairman.
Wm. E. Livingston.
Henry H. Wilder, resigned Sept. 26, 1871.
Samuel K. Hutchinson, elected to fill vacancy.

WATER BOARD.

1873.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Jonathan P. Folsom, alderman.
Nathaniel C. Sanborn, councilman.
Nathan W. Frye, councilman.

1874.

Levi Sprague, president, from the citizens.
William F. Salmon, from the citizens.
Nathaniel C. Sanborn, alderman.
Nathan W. Frye, councilman.
G. W. S. Hurd, councilman.

1875.

Geo. Runels, president, from the citizens, re-
signed Nov. 9, 1875.
Cyrus H. Latham, president pro tem., from the
citizens.
Benj. Walker, alderman.
Albert A. Haggett, councilman.
Earl A. Thissell, councilman.

1876.

Cyrus H. Latham, president, from the citizens.
Earl A. Thissell, from the citizens.
Albert A. Haggett, alderman.
Benj. C. Dean, councilman, resigned May, 1876.
John F. Kimball, councilman, elected to fill
vacancy.
Orford R. Blood, councilman.

1877.

Cyrus H. Latham, president, from the citizens.
Albert A. Haggett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
James W. Bennett, councilman.

1878.

Albert A. Haggett, president, from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
John F. Kimball, councilman.
Charles H. Harvey, councilman.

1879.

Albert A. Haggett, president, from the citizens.
James W. Bennett, from the citizens.
Horace R. Barker, alderman.
Edward B. Pierce, councilman.
Robert G. Bartlett, councilman.

1880.

Albert A. Haggett, president, from the citizens.
James W. Bennett, from the citizens.
Robert Wood, alderman.
Charles C. Hutchinson, councilman.
Edward B. Pierce, councilman.

*Investigations were made at various times, by order of the City Council, for the introduction of pure water into the city, viz.:
By Joint Special Committee, consisting of the following named citizens:*

1828.

Oliver M. Whipple, alderman.
George Brownell, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.
John Clark, alderman.
Thomas Hopkinson, councilman.
Benjamin Walker, councilman.
John Nesmith, councilman.

1848.

Jefferson Bancroft, mayor.
Oliver M. Whipple, alderman.
David Dana, alderman.
John Avery, councilman.
Otis L. Allen, councilman.
Thomas Hopkinson, councilman.
Ignatius Tyler, councilman.

1865.


George W. Norris, alderman.
Edward F. Watson, alderman.
Charles W. Dodge, councilman.
T. L. P. Lamson, councilman.
John Pearson, councilman.

1866.

Josiah G. Abbott, mayor.
Charles W. Dodge, alderman.
Joseph L. Sargent, alderman.
Benjamin Walker, councilman.
Edward C. Rice, councilman.

WATER BOARD, 1887.

<i>President</i>	-	-	-	C. A. R. DIMON.	Term expires first Monday in May, 1888.
				MILES F. BRENNAN.	Term expires first Monday in May, 1889.
				Alderman MARCELLUS H. FLETCHER.	
				Councilman JOHN E. DRURY.	Councilman DANIEL J. CLEARY.
				Clerk	- - - HORACE H. KNAPP.
<i>Superintendent of Works</i>	-	-	-	-	- Robert J. Thomas.
<i>Foreman of Works</i>	-	-	-	-	- Thomas Doyle
<i>Engineer at Pumping Station</i>	-	-	-	-	- Lewis Stiles.
<i>Service Clerk</i>	-	-	-	-	- Leonard T. Farris.
				<i>Inspectors.</i>	
				John J. Bancroft.	Thomas E. Lennon.
				Willard S. Knowlton.	Julian L. Whiteside.
				<i>Meter Inspector.</i>	
				ROBERT GARDNER.	

 The Water Office is open daily from 9 A. M. to 3 P. M., and on Monday evenings from 7 to 8 o'clock.

REPORT OF THE WATER BOARD.

OFFICE OF THE LOWELL WATER BOARD,
LOWELL, MASS., Jan. 10, 1888.

To the City Council of the City of Lowell:

GENTLEMEN,—We have the honor to herewith present the Fifteenth Annual Report of the Lowell Water Board.

In every department of the works harmony and efficient honest service has prevailed, and we consider the condition of all branches to be excellent.

The surplus of moneys received, over all expenditures, for the year 1887 is \$5,384.59, and we can report the Water Works, for the first time in its history, self-sustaining, without appropriations from your honorable body, and with a considerable balance in its favor. Taking out the \$3,000 that was appropriated to the works by your board in 1886, there was a balance in its favor Jan. 1, 1887, of about one thousand dollars.

We have already recommended to the City Council a reduction of charges for the use of water, as follows: For a family of six persons, from \$6.00 to \$5.00, and that the minimum first charge for a meter be made \$10.00 in place of \$12.00 as now placed, and that the

voir, and the old dwelling-house belonging to the city, that was located in an unsightly position, nearly in front of the reservoir and in the way of the new street, was moved back about two hundred yards, and put in perfect repair. A permanent watchman has been placed in charge of both reservoirs, and the grounds around the main reservoir have been put in presentable condition and kept so, with new iron seats on the reservoir bank and a drinking-fountain near the front gate. The reservoir gate-house has been repaired, and the reservoir and surroundings are now an ornament to the city, a source of pride to our citizens, and a pleasure to visitors in summer.

We would refer you to the able and complete reports of the Superintendent and the City Engineer, herewith annexed, for further details of the workings of the several departments.

Owing to the non-election of new members of the board, by the City Council, the old board held over, and the first meeting of the new board was not held until March 14, 1887. The board consisted of the following members: Walter Coburn, president, and C. A. R. Dimon, from the citizens, and Alderman M. H. Fletcher and Councilmen John E. Drury and Daniel J. Cleary, from the City Council.

ORGANIZATION.

The annual organization occurred on May 2, 1887. The board then was composed of Charles A. R. Dimon

four months of 1887 amounted to \$39,383.97, all of which was not quite due at closing of the books. The number of water takers was about fifteen thousand.

The total amount of water pumped during the year was 1,578,992,610 U. S. gallons, an increase over the year 1886 of 137,369,970 U. S. gallons. The daily average was 4,326,007 U. S. gallons pumped into the low service, and 57,015 U. S. gallons pumped into the high service, reservoir, an increased daily average over the year 1886, in the low service, of 376,356 U. S. gallons.

1,467 $\frac{1}{2}$ tons of coal have been used during the year, 312 $\frac{5}{8}$ tons of which were used for the high service engine; 225 $\frac{1}{2}$ tons for the Worthington engine; 1210 $\frac{1}{2}$ tons for the Morris engine.

There have been 333 gallons of water raised 78.91 feet high for each pound of coal consumed by the high service engine, 425 gallons raised 163.70 feet high for each pound of coal consumed by the Worthington engine, and 573 gallons raised 162.82 feet high for each pound of coal consumed by the Morris engine.

The cost of pumping 1,000,000 gallons was \$6.65 in 1887, by the Morris engine, and \$7.89 in 1886, by the Worthington engine. With the cost of coal increased, the cost of pumping in 1887 has exceeded that of 1886, but the following table will show that with coal in 1887 at the same price as in 1886, the cost of pumping in 1887, then, has been decreased from that of 1886; and that there have been more gallons of water raised from one pound of coal than for some time, if ever before,

CHARGES FOR WATER BY MONTHS, FROM COMMENCEMENT TO DECEMBER 31, 1887.

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
January,	-----	\$ 363 94	\$ 418 96	\$ 150 45	\$ 126 51	\$ 169 14	\$ 282 44	\$ 233 73	\$ 182 58	\$ 233 37	\$ 271 52	\$ 472 76	\$ 702 05	\$ 410 21	427 66
February,	-----	35 53	235 43	238 85	86 84	144 38	238 19	349 08	146 40	139 22	136 08	347 68	352 00	439 68	439 98
March.	\$6,124 94	50,200 10	65,417 68	82,249 51	89,177 52	82,225 43	80,603 69	80,567 44	89 210 88	90,856 37	94 956 65	98,692 13	102,961 30	104,537 77	111,281 68
April,	783 89	1,739 50	935 20	265 34	584 11	1,970 12	9,242 84	6,478 39	540 20	403 64	263 10	351 78	439 64	1,355 01	773 67
May,	2,988 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61	1,191 41	984 84	1,495 90	1,662 34	1,760 48	2,067 80
June,	5,818 78	2,865 86	2,887 43	4,460 91	2,389 52	3,908 69	6,126 86	868 08	12,574 12	16,401 62	17,757 44	18,769 27	21,203 61	23,768 43	23,017 09
July,	4,833 52	1,889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	273 00	959 80	1,059 37	899 21	1,063 36	1,434 99	2,383 37
August,	2,728 30	498 50	449 86	771 87	709 88	677 01	563 35	459 17	514 46	634 40	902 76	984 17	828 40	1,173 44	927 05
September.	2,827 07	32,45 06	865 90	495 97	3,493 90	4,998 07	6,584 86	8,108 23	10,088 19	10,904 30	12,467 32	12,939 94	13,452 97	16,105 05	18,397 55
October	9,729 05	872 10	2,947 93	4,893 44	543 79	663 80	454 29	338 51	309 22	552 27	941 81	738 12	697 87	783 29	1,108 16
November,	761 21	634 03	573 35	1,445 65	518 72	1,220 27	1 405 89	620 56	873 16	378 97	1,615 65	693 41	477 10	686 02	683 55
December,	1,571 72	3,689 79	3,955 59	3,246 39	4,040 71	4,522 75	5,794 77	7,851 52	9 593 32	10,848 04	12,512 70	12,544 55	12,617 45	12,825 41	15,927 35
Total,	\$39 168 64	\$69,307 39	\$82,861 60	\$99,674 93	\$98,178 93	\$102,877 32	\$115,261 20	\$118,808 70	\$125,975 27	\$133 503 45	\$143,849 22	\$148,028 85	\$155,848 94	\$165,279 78	\$177,425 51
Less abate- ments to date	-----	1,872 83	640 06	8,185 88	2,502 65	4,343 13	9 590 05	1,702 13	3,766 88	2,450 50	3,094 15	4,314 79	3,946 34	2,991 18	2 367 70
Net amount,	\$39,168 64	\$67,434 56	\$82,221 54	\$91 489 05	\$95 676 28	\$98,534 19	\$105,671 15	\$117,106 58	\$122 208 39	\$131,012 95	\$140,775 07	\$144,614 06	\$151,902 64	\$162,288 60	\$175,057 81

<i>Amounts brought forward</i>	\$13,139 54	\$2,384,572 31
Lead	931 67	
Hardware	21 57	
Teaming pipe.....	185 46	
Supplies	110 27	
Freight	807 19	
Wood	8 00	
Water-gates	244 84	
Sidewalk-cocks	441 75	
Kyanized plank	47 07	
Brass castings	36 79	
Sidewalk-boxes	816 94	
Cellar-cocks	441 25	
Dualin and exploders.....	37 33	
Corporation cocks	416 92	
Clay pipe	73 32	
Hydrants.....	186 96	
Hydrant-boxes.....	154 40	
Hydrant repairing .	21 40	
Hydrant freight	2 05	
Hydrant cases.....	94 38	
	<hr/>	
	\$18,219 10	

LABOR, PAY-ROLL, —

Extensions	\$4,845 71	
Services	3,366 97	
	<hr/>	
	8,212 68	
	<hr/>	
Total construction account.....	\$26,431 78	

MAINTENANCE.

EXPENDED FOR CURRENT EXPENSES, REPAIRS, PUMP-
ING, ETC., VIZ.:

OFFICE, PIPE YARD, STABLES, ETC.

Printing 1886 Report.....	\$ 78 00	
Paper, ink, pens, etc.....	216 87	
Horse-car tickets.....	22 00	
	<hr/>	
<i>Amounts carried forward</i>	\$316 87	\$2,384,572 31

<i>Amounts brought forward</i>	\$ 486 81	\$2,384,572 31
Sundries.....	93 78	.
Labor, pay roll.....	4,105 89	
	<hr/>	
Total repairs.....	\$4,686 48	
	<hr/>	

PUMPING ACCOUNT.

Iron casting.....	\$ 27 10	
Gas	178 52	
Oil.....	201 73	
Packing.....	26 24	
Belting.....	15 54	
Steel.....	7 75	
Coal.....	5,248 58	
Examination of engine.....	140 00	
Sundries.....	76 33	
Waste.....	35 00	
Labor, pay roll.....	4,110 14	
	<hr/>	
Total pumping account.....	\$10,066 93	
	<hr/>	

METER ACCOUNT.

Meters purchased.....	\$2,276 99	
Drawing sketches.....	\$ 76 33	
Freight.....	6 73	
Repairs on meters.....	202 72	
Brass castings.....	63 49	
Hardware.....	3 42	
Second hand meter..	10 00	
Labor, pay roll.....	2,254 50	
	<hr/>	
	2,617 19	
	<hr/>	
Total meter account.....	\$4,894 18	
	<hr/>	

RESERVOIR, BEACON STREET.

Repairing house.....	\$312 96	
Iron stairs.....	300 00	
	<hr/>	
<i>Amounts carried forward</i>	\$612 96	\$2,384,572 31

Amount brought forward \$2,561,478 36

CREDITS.

Amounts received by the City Treasurer during the
year, for water rates, service pipes and sundries,
viz :

For account of 1883.....	\$	8	10
For account of 1884.....		30	95
For account of 1885.....		122	29
For account of 1886....		18,177	85
For account of 1887.....		159,895	10

Total receipts for the year.....		\$178,234	29
----------------------------------	--	-----------	----

Net cost of works, including interest on Water Loan to Jan. 1, 1888.....		\$2,383,244	07
---	--	-------------	----

Present debt of the city, by bonds and notes, on account of construction of Water Works.....		1,834,000	00
--	--	-----------	----

Total amount paid from the City Treas- ury to Jan. 1, 1888, by taxation, on account of Water Works, in excess of receipts from loans and water rates.....		549,244	07
---	--	---------	----

Value of Water Works Sinking Fund, Jan. 1, 1888.		570,250	10
--	--	---------	----

\$1,119,494 17

Net cost of Works, including interest on Water Loan, to Jan. 1, 1888.....		\$2,383,244	07
--	--	-------------	----

Whole amount paid by taxation, and by appropriation for the Sinking Funds, and the value of said funds, Jan. 1, 1888		1,119,494	17
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Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, Jan. 1, 1888.....		\$1,263,749	90
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The following table will show the expenditures and receipts of the Works from 1873 to 1888, exclusive of interest on the Water Debt:

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873	\$188,376 59	\$57,739 48	\$130,637 11	
1874	128,105 63	80,625 65	47,479 98	
1875	170,095 78	94,908 14	75,187 64	
1876	115,012 24	98,815 54	16,196 70	
1877	53,988 72	100,826 63		\$46,837 91
1878	49,900 15	104,142 87		54 242 72
1879	42,157 82	110,185 34		68,027 52
1880	45,031 59	123,740 49		78,708 90
*1881	121,601 27	128,053 97		6,452 70
†1882	64,525 92	140,397 96		75,872 04
1883	65,673 23	152,582 99		86,909 76
1884	64,982 71	154,437 55		89,454 84
‡1885	64,030 24	157,956 79		93,926 55
1886	51,808 52	168,757 53		116,949 01
§1887	62,236 05	178,234 29		115,998 24

Taking into consideration the fact that Mr. Robert J. Thomas, as superintendent, and Mr. Lewis

*In 1881 there were expended the following extraordinary amounts: For river crossing, 24-inch reserve line, \$9,968.59; for high service water supply, \$57,969.89.

†In 1882, high service water supply, \$10,898.59.

‡In 1883, Beacon street reservoir, \$14,766.27.

§In 1887, changing cement pipe, Central, Broadway and Middlesex streets, \$10,488.74.

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68, \$86,770.63, \$108,692.82 and \$126,455.98.

measure, the very successful years' operation of the engineers at the station.

CONDITION OF WATER SUPPLY.

While there is no doubt but that our water is as pure as that used in the majority of cities, yet the board have given the question of how to keep it up to the standard of the past, careful thought and watchful care.

We have had monthly reports of a chemical analysis of the water from the Merrimack river and do not feel that there is any cause for alarm in those reports at present, yet we feel it is imperative that some means should be taken at once to meet this growing impurity, either by a system of a new supply from some of the numerous surrounding spring water ponds, or by a more thorough plan of filtration, aeration, and settling basins of the present supply. Your board have already adopted a system of aeration in winter by running the water at the reservoir gate house over a plank platform about six feet wide and allowing it to fall in a broad, thin stream some seven feet into the reservoir, and also have had in contemplation the erecting of stand pipes short distances apart, connecting with and over the conduit which runs from the inlet wells on Merrimack river to the pumping station, thus taking off any foul air that may collect in that long pipe.

As you are perhaps aware, there is now a filtering basin some 1,400 feet long on the up river side

SUMMARY OF STATISTICS.

REPORT OF 1887.

IN ACCORDANCE OF SUGGESTIONS ADOPTED BY THE NEW ENGLAND
WATER WORKS ASSOCIATION.

LOWELL WATER WORKS, LOWELL, MASS.

Population by census of 1885, 64,051.

Date of construction, 1870 to 1872 inclusive.

Owned by the City of Lowell.

The source of supply is from the Merrimack River.

The mode of supply is by pumping, and consists of one Morris pump and one Worthington pump of 5,000,000 gallons daily capacity each.

The kind of coal used is Elk Garden, Cumberland.

Cost of coal is \$4.97 per ton of 2240 pounds.

	MORRIS.	WORTHINGTON.
Coal consumed for the year in lbs.	2,421,350	451,300
Total pumping in gallons.....	1,387,277,760	191,714,850
Average head, including friction, in feet.	162.52	163.79
No. of gallons pumped per lbs. of coal.....	573	425
Duty on total coal consumed, no deduction for anything.....	77,600,802	57,987,101
Cost of pumping, figured on pumping station expenses.....	\$9,216.57	\$1,513.41
Per million gallons into reservoir..	\$6.65	\$7.89
Per million gallons one foot pipe. .	.04 $\frac{17}{100}$	.04 $\frac{18}{100}$

CONSUMPTION.

Estimated population to date, 70,000.

Estimated population supplied, 68,000.

Total number of gallons consumed for year, 1,576,495,007.

FIFTEENTH ANNUAL REPORT

OF THE

Engineer, to the Water Board.

JANUARY 1, 1888,

SUMMARY OF STATISTICS.

Total number of gallons metered, 352,338,750.

Average daily consumption in gallons, 4,319,164.



WATER CONSUMPTION

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|
Balanc
Water
Meter

\$182,290 67

\$182,290 67

FIFTEENTH ANNUAL REPORT
OF THE
City Engineer, to the Water Board.

JANUARY 1, 1888,

REPORT OF THE ENGINEER.

OFFICE OF CITY ENGINEER,
LOWELL, MASS., Jan. 2, 1888.

To the Lowell Water Board:

GENTLEMEN—The following is the Fifteenth Annual Report of the work done by the pumping engines of the Lowell Water Works:

The calculations of the duty of the engines were made from the records kept by the engineers in charge, Mr. James P. Roberts from Jan. 1, to March 22, 1887, and Mr. Lewis Stiles from March 22 to Jan. 1, 1888.

All the coal used at the pumping station has been charged to pumping, no deduction of any kind having been made for heating the building or running the small stationary engine used to furnish the power for the machine shop.

All repairs on the engines and boilers have been done by the engineers in charge and their assistants.

The average cost of pumping one million gallons from the Low Service Reservoir to the High Service Reservoir is eight dollars and seventy-seven cents.

Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1887.

MONTHS.	No. of days pump-ing.	Ave. No. of hours pumping per day.	Number of hours pumping per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water raised in- to reserv-oir per lb. of total coal con- sumed.	Duty in lbs., 1 foot high, with 100 lbs. coal, used in pump- ing only, no de- duction for ashes or clink-ers.	Duty on total coal consumed, no deduction for ashes or clink-ers.
January - - -	9	19-49	178-25	89 141	8.33	168.05	27,633,710	3,070,412	439.	70,366,921	61,431,439
February - - -											
March - - -	3	10-50	32-30	22,870	11.73	162 71	7,089,700	2,363,233	430.	69,164,111	58,265,527
April - - -	5	19-00	95-00	74,862	13.13	162 95	23,207,220	4,641,444	431.	66,771,171	58,579,973
May - - -	9	19-40	177-00	139,443	13.13	163.61	43,227,330	4,803,037	437.	68,061,859	59,536,944
June - - -											
July - - -	7	19-04	133-30	96,331	12.03	163.29	29,862,610	4,266,087	408.	63,998,109	55,441,736
August - - -	4	21-00	84-00	62,113	12.32	163.08	19,255,030	4,813,757	422.	65,424,194	57,389,650
September - - -	5	18-36	93-00	66,290	11.88	163.34	20,549,900	4,109,980	425.	67,084,108	57,917,345
October - - -											
November - - -	5	17-03	85-15	67,385	13.17	163.27	20,889,350	4,177,870	403.	61,523 744	54,872,529
December - - -											
Totals and Averages.	47	18-42	878-40	618,435	11.73	163.79	191,714,850	4,079,039	425.	66,403,394	57,987,101

Table Showing Work Done with Worthington High Service Engine for each Month During the Year 1887.

MONTHS	No. of days pump-ing.	Ave. No. of hours pump-ing per day.	Number of hours pumping per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water pump'd in to reserv-oir per lb. of total coal con-sumed.	Coal in lbs. used when pumping.
January - - -	4	15-57	63-50	123,816	32.33	78.67	1,733,424	433,356	333.	5,210
February - - -	4	11-22	45-30	112,182	41.09	78.67	1,570,548	392,637	346.	4,540
March - - -	4	10-30	42-00	96,426	38.26	78.09	1,349,964	337,491	321.	4,200
April - - -	5	11-06	55-30	121,603	36.52	78.67	1,702,442	340,488	334.	5,100
May - - -	4	12-30	50-00	114,389	38.13	78.95	1,601,446	400,361	320.	5,000
June - - -	5	13-09	65-15	149,810	37.98	78.44	2,097,310	419,468	375.	5,600
July - - -	5	14-03	70-15	148,739	35.29	78.67	2,082,346	416,469	306.	6,800
August - - -	4	12-45	51-00	110,818	36.22	79.82	1,551,452	387,863	317.	4,900
September - - -	5	14-12	71-00	142,617	33.48	78.90	1,996,638	399,327	322.	6,200
October - - -	4	12-07	48-30	113,615	39.04	78.67	1,590,610	397,652	346.	4,600
November - - -	4	11-00	44-00	96,479	36.55	79.52	1,350,706	337,676	322.	4,200
December - - -	6	12-00	72-00	155,963	36.10	79.82	2,183,482	363,914	352.	6,200
Totals and Averages.	54	12-35	679-20	1,486,457	36.47	78.91	20,810,398	385,378	333.	62,550

<i>Amount brought forward</i>	\$1,501 72
8½ pounds soapstone packing, at 30 cents.....	2 55
Tools and stock.....	4 41
Sundries.....	4 73
Total	\$1,513 41

Cost of raising water into reservoir, per million gallons.	\$7 89
Cost of raising water one foot high, per million gallons..	.04 ⁸ / ₁₀₀

RESERVOIR, BEACON STREET, 1887.

MONTHS.	Depth in feet.	Quantity in U. S. gallons.	Temperature in degrees.	
			Of water.	Of air.
January	17.81	26,872,127	32.17	23.87
February	18.42	27,877,323	32.58	29.62
March	17.49	26,338,141	32.33	31.95
April	18.18	27,477,112	39.69	45.26
May	18.25	27,587,388	57.01	64.00
June	18.56	28,112,484	66.88	69.74
July	18.50	28,001,761	75.55	78.66
August	18.75	28,417,395	72.61	70.08
September	18.91	28,696,576	64.68	60.74
October	19.09	28,984,687	54.27	49.76
November	19.14	29,064,137	42.08	39.60
December	19.03	28,880,241	35.35	29.59

FIFTEENTH ANNUAL REPORT

OF THE

Superintendent, to the Water Board.

.....

JANUARY 10, 1888.

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REPORT OF SUPERINTENDENT.

SUPERINTENDENT'S OFFICE, CITY HALL,
LOWELL, Jan. 2, 1888.

To the Lowell Water Board :

GENTLEMEN—I have the honor of presenting to you, in accordance with a provision of the city ordinances, the Fifteenth Annual Report of the Superintendent of the Lowell Water Works for the year ending December 31, 1887, and in doing so it gives me great pleasure to be able to report that the department is at last self-sustaining, and that notwithstanding the extraordinary amount of work done this year we still have a large balance left.

FILTER INLET, GALLERY AND CONDUIT.

The filter gallery and conduit are in good condition, no repairs having been necessary the past year. The filter inlet, so called, where it was intended to have the water come from the river into and through a filter bed of fine sand and gravel, thence into the gallery, is at present, and has been for years, practically of no use. This is owing to the fact that there is no barrier to the high water in the river overflowing and washing silt mud and other matter into the basin, thereby preventing the water from filtering through. This probably can be remedied

sewer in the driveway. In pursuance of a vote of the board I had twelve settees placed at different points around the reservoir. We also set a drinking fountain inside the entrance at the head of Beacon street for the accommodation of visitors. When cleaning the screens situated in the efflux chamber at the gate house where the water comes into the city, we found the planks which set on the top of the screens to be rotted to such an extent that fish and other matter was liable to pass through into the pipes. These were replaced by new planks, and a new set of screens ought to be built to have in readiness to replace the old ones the next time they are cleaned, as they are also in a bad condition. No improvements have been made at the high service reservoir.

EXTENSIONS.

During the past year the cast iron main pipe has been extended 9,116 feet, which is 1,687 feet less than was laid last year. Of the amount laid this year 876 feet was laid on the high service line. The prospect for next year is that the demand for extension will not be as great as this year. Complete figures of the size and location of the pipe laid this year have been made by Mr. Foster of the engineer's office, and accompany this report.

RELAYING MAIN PIPE.

For a number of years back the cement lines of pipe in use in the city, situated on Central, Broadway and Middlesex streets, had become in such an unsafe condition that they were liable to burst at any time, and it was thought impracticable to tap them for service pipes.

LEAKS.

The greatest number of leaks this year were found in service pipes. Some of them were caused by back filling in sewers, and a few were found to have been eaten through where the ground was filled in by cinders and ashes. We had about fifteen leaks in service pipes altogether. We had two leaks in force main on Sixth street. Both of them occurred the same day, which is the case almost every year since the pipe was first laid. We also discovered about the first of May a leak in 24-inch main connection on Stackpole street, caused by the giving out of a lead joint. This same connection leaked last year, and is likely to give trouble again in the future unless the 24-inch main is extended and a new connection made.

SERVICES.

The total number of feet of service pipe laid the past year shows an increase of 3,429 feet over the year 1886. Of the number of services 331 were new and 157 were changes, caused in most cases by the old iron service becoming filled with rust. There can be no doubt but that every three-fourths inch iron water pipe in the city will have to be changed, eventually, for lead or larger iron. During the year past, while we have allowed all applicants for service pipe to name the kind of pipe required, we have in no case laid less than one inch iron, and we have always recommended lead pipe. This we have done because lead pipe which has been taken up after being in the ground a number of years we found perfectly clean and containing no obstruction to the flow of water, whereas iron pipe under the same conditions was found to be so rusted as to reduce the capacity of the pipe over one-half, and in some cases completely stopping the flow of water through the pipe.

METERS.

There are now in use 1,530, an increase over last year of 69; new meters set during the year, 82, an increase of 22 over last year; meters taken out and others set in their places, 16; meters discontinued this year, 7; meters taken out for repairs, 214; meters destroyed by freezing, 2; tops bursted on crown meters by freezing, 4; Worthington meters cleaned and repaired, 43; Desper meters repaired at pumping station, 123. Total amount of money received for metered water, \$75,027.36.

Meters Running January 1, 1888.

SIZE IN INCHES.	$\frac{1}{4}$ in.	$\frac{1}{2}$ in.	1 in.	1 $\frac{1}{2}$ in.	2 in.	3 in.	4 in.	Motor Regis- ter.	Total.
Desper.....	503	152	68	1					724
Worthington.	279	25	47	69	26	5	2		453
Crown.....	97	120	52	1	6		1		277
Ball & Fitts..	17	9	2	1					29
Duplex.....	12	14	10						36
Fitts Rotary.	6								6
Motor Regstr.								5	5
Total.....	914	320	179	72	32	5	3	5	1530

EXTENSION OF SMALL PIPE.

Small wrought iron main pipe to the extent of 2,543 feet has been laid during the year, the size of the pipe varying from one to two inches. This is 2,265 feet in excess of the amount laid in 1886. This pipe was laid in small courts where only a few houses would ever need water, or in streets where the grade or lines were liable

street was finished, together with seventy-eight feet of new pipe, which took the place of the pipe that was broken and lost in the sewer.

A thirty-inch pipe drinking fountain was set by the department at the junction of Bridge and Hampshire streets.

Three new four-inch fire services were laid during the year, two of them with four-inch hydrants connected for private use.

Previous to this year hauling the pipe from the cars to the yard, and from the yard to the streets where extensions were called for, was done by B. F. Brown, but owing to his refusal to do it at the same price this year and the inconvenience of delay in delivering the pipe when and where it was wanted, upon my suggestion another horse was purchased, also the truck used by Mr. Brown for that purpose. Since then the department has done all its own teaming of pipe, sand, paving, etc., saving thereby a considerably sum which was annually expended in this manner; also giving the department another horse, which was very much needed, as the three horses we had were overworked, due to the great increase in the territory supplied by the water works.

CONCLUSION.

I cannot close this report without speaking a good word for the employes of the department, both for those employed in the office and on the outdoor work. No man would want more faithful and intelligent work than they have performed the past year, and to them in a great degree is due the success which the department has attained.

I also cheerfully accord to the President and members of the Water Board my grateful thanks for their kindness and the confidence they placed in me during my official connection with the department this year.

Respectfully submitted.

ROBERT J. THOMAS,
Superintendent.

LOW SERVICE—WATER PIPES LAID IN 1887.

~~TABLE~~

LOW SERVICE—LIST OF HYDRANTS SET DURING THE YEAR 1887.

STREETS.	LOCATION.
†Bassett . . .	Northwesterly side, 2½ feet west of Hudson street.
*†Broadway . . .	Northerly side, 258½ feet west of Mt. Vernon street.
*†Broadway . . .	Northerly side, 222½ feet east of Mt. Vernon street.
*†Broadway . . .	Northerly side, 4 feet west of Willie street.
*†Broadway . . .	Northerly side, at line of Fletcher street.
*Central . . .	Westerly side, opposite Abbott street.
*Central . . .	Westerly side, 17 feet south of Elm street.
*Central . . .	Westerly side, opposite Cady street.
*†Middlesex . . .	Southerly side, 94 feet west of Bowditch street.
*†Middlesex . . .	Southerly side, near west line of Elliot street.
*Middlesex . . .	Southerly side, near west line of South street.
*Middlesex . . .	Southerly side, near east line of Pearl street.
Parker . . .	Northerly side, 6 feet east of Stevens street.
Parker . . .	Northerly side, about 71 feet east of Wilder street.
Pleasant . . .	Westerly side, 11 feet north of Rogers Farm line.
Tanner . . .	Southeasterly side, 217 feet northeasterly from St. Hyacinthe street.
Thorndike . . .	Easterly side, 267 feet north of south line Highland street.
†Watson Avenue .	Northerly side, about 114 feet from Chelmsford street.

† Flush hydrants.

* Old pattern taken out.

Taken out, hydrant on westerly side of Central street, near south line of Centre street.

Hydrant on Western avenue, opposite Elevator building, changed from flush to post hydrant.

Property at Pipe Yard January 1, 1888.

SCHEDULE OF MAIN PIPE AND SPECIAL CASTINGS.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths	65	8	6	24	50	5	17	8	4
Bleoves	7	4	6	5	2	10	6	9	7
Caps		14	23	8	16	3	1	1	
Curves	6	4	12	2	8	4	10	3	
Plugs	2	7							

Stop gates, 1 4-inch, 2 6-inch; wrought iron pipe, 12 feet 1½-inch, 24 feet 2-inch; 1 reel ¾-inch lead pipe, 1 reel ¾-inch lead pipe, 40 feet 1-inch; 7 ¾-inch tees; 10 1½-inch crosses, 12 1x¾-inch, 12 ¾-inch elbows, 8 1x¾-inch, 16 2-inch unions; 6 2x1½-inch bushings; 15 1-inch plugs; 20 reducing couplings; 39 ¾-inch solder nipples; 10 1-inch sidewalk cocks; 11 unions; corporation cocks, 6 ¾-inch; 2 1-inch cellar cocks; 4 1-inch iron sidewalk cocks, 30 ¾-inch; 18 1-inch lead unions, 18 ¾-inch; 1 1-inch bushing, brass; 7 brass plugs, 15 ¾-inch; 2 iron hydrant boxes, 1 stop gate box, 6 iron sidewalk boxes, 7 joints earthen pipe for sidewalk boxes, 2 buck saws, 2 saw horses, 1 machine for testing main pipe, 2 pipe benches, 2 tool boxes, 3 derricks, 2 fall ropes, 2 set blocks, 6 draught chains, 10 wheelbarrows, 2 tongs for cleaning sidewalk boxes, 4 hydrant frames, 10 hydrant covers, 2 gate box frames, 2 gate box covers, 2 drinking fountains, 24 picks, 18 pick handles, 7 square point shovels, 20 round point shovels, 10 scrub brooms, 4 hand brushes, 11 pair rubber boots, 15 lanterns, 30 feet rubber hose, 1 hose reel, 2 brass goose necks, 6 calking sets, 3 nail hammers, 100 sidewalk box caps, 200 feet canvas hose, 300 feet 2½-inch rubber hose, 30 iron lug straps, 250 pounds assorted bolts, 12 assorted files, 12 assorted gravel screens, 20 pounds cotton waste, 2 trowels, 10 pounds iron washers, 30 pounds assorted nuts, 3 hand hatchets, 1 ax, 5 sling ropes, 1 dualin pot, 9 striking hammers, 4 hand hammers, 2 paving hammers, 200 pounds pig lead, sets old blocks, 2 lead pots, furnace for melting lead, 1 zinc pump, 2 copper force pumps, ½ keg 30d nails, 40 assorted wrenches, 14 rammers, 3 paving mauls, 1 barrel cement, ½ barrel white clay, 1 snow shovel, 1 blacksmith shop, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 2 spirit levels, 3,000 feet lumber,

Lowell, 1 instrument for testing capacity of engines, 1 apparatus for making gate boxes, 1 hat rack, 1 umbrella rack, 1 water cooler.

Property and Tools at Pumping Station.

1 pipe vise, 1 work bench, 1 portable forge, 8 sets of braces for engines, 2 sets differential blocks, 100 feet 2 inch rope, 1 set fire irons, 1 brass hydrant, 1 axe, 11 finished wrenches, 3 hand saws, 2 jack screws, 1 cold chisel, 2 ratchet drills, 1 socket drill, 4 calking chisels, 1 barometer, 2 thermometers, 1 office desk, 1 indicator, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crow bars, 64 feet $\frac{3}{4}$ -inch iron chain, 16 eye bolts, 1 truck, 1 key wrench for air pump, 1 iron wheelbarrow, 1 buck saw, 2 gas lamps, 1 high grade thermometer, 4 brass bolts, 4 spare valves for Morris engine, 5 sets spare wrenches for valves, 11 wrenches for Morris engine, 11 wrenches for Worthington, 3 sledge hammers, 10 drills, assorted sizes, 5 bits, 2 bit stocks, 1 25-foot ladder, 1 20-foot and 1 18-foot, 1 pair steps, 1 hoe, 2 rakes, 1 small die plate, 1 fore plane, 6 monkey wrenches, 1 piece 2-inch rope, 3 chisel bars, 2 small taps, 4 socket wrenches, 2 14-quart iron pails, 4 hand hammers, 2 grind stones, 1 anvil, 7 gas tongs, 1 hydrant wrench, 2 clocks, 1 full set of dies, from $\frac{1}{4}$ -inch to 2-inch ratchett right and left, with 2 die plates, 1 die stock and bushings, 2 sets blocks, 3 $\frac{1}{4}$ -inch chains, 1 24-inch elbow, 1 ratchett wrench for 30-inch gate, 1 scythe, 1 snath, 7 chairs, 1 office table, 2 engine lathes, 1 speed lathe, 1 upright drill, 31 turning tools, 1 12-inch chuck, 1 6-inch chuck, 1 number 3 drill chuck, 1 number 2 drill chuck, 3 reamers for Desper meters, 4 small reamers, 16 twist drills, 3 lanterns. Extras—2 bench vises, 4 assorted steel wrenches, 1 meter chuck, 1 black walnut book case, 1 black walnut cabinet, 1 small slide valve engine, 3 extra twist drills, 12 lathe dogs, 3 hack saws, 1 blow pipe, 1 hay scales, 2 small jack screws, 1 small Scotch drill, 1 furnace pot, 2 trowels, 1 tar kettle, 450 feet sheathing, 3 wheelbarrows, 2 pipe cutters.

Property at Reservoir.

1 iron tooth rake, 1 hay fork, 3 shovels, 1 ax, 1 piece 1-inch rope, 1 scythe and snath, 1 grass hook, 3 thermometers, 1 stop gate wrench, 1 sidewalk wrench, 1 coal stove, 2 lanterns, 1 ice chisel, 1 nail hammer, 1 saw, 1 carpenter's square, 2 hoes, 1 piece rubber hose, 2 chairs, 1 sectional ladder, 1 dwelling house, 1 stable, 1 wheelbarrow.

Tools and Property at Filter Inlet.

2 iron tooth rakes, 11 shovels, 1 rammer, 1 ax, 2 ice chisels, 1 stop gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow, 1 boat, 1 set of oars.

SIXTEENTH
ANNUAL REPORT
OF THE
LOWELL WATER BOARD,
TO THE
CITY COUNCIL OF THE CITY OF LOWELL, MASS.,
AND THE
REPORTS OF THE SUPERINTENDENT OF WATER WORKS AND
OF THE CITY ENGINEER TO THE WATER
BOARD, FOR 1888.

LOWELL, MASS.
VOX POPULI PRESS, 130 CENTRAL STREET.
1889.

42848

903

CITY OF LOWELL.

IN BOARD OF ALDERMEN, Jan. 22, 1889.

Received and ordered on file without reading.

Sent down for concurrence.

GIRARD P. DADMAN, *City Clerk.*

IN COMMON COUNCIL, Jan. 22, 1889.

Received and ordered on file, in concurrence.

DAVID CHASE, *Clerk.*

WATER DEPARTMENT, 1888.

WATER BOARD.

MILES F. BRENNAN, *President.*

EDWARD D. HOLDEN.

HARRY E. SHAW.

EDMUND B. CONANT.

ARNOLD S. WELCH.

CHAS. L. KNAPP, *Secretary and Clerk.*

ROBERT J. THOMAS, *Superintendent.*

THOMAS F. DOYLE, *Foreman.*

ROBERT GARDNER, *Meter Inspector.*

WILLIAM JOYCE, *Assistant Foreman.*

ANTHONY F. COGER, *Services.*

LEONARD T. FARRIS, *Service Clerk.*

GEORGE W. WORTHEN, *Meter Clerk.*

MARY G. SAWYER, *Assistant Clerk.*

JAMES P. ROBERTS, *Engineer.*

THOMAS McLAUGHLIN, *Asst. Engineer.*

Inspectors.

JOHN J. BANCROFT.

JULIAN L. WHITESIDE.

THOMAS LENNON.

WILLARD S. KNOWLTON.

FRANK LAPOINT, *Reservoir.*

REPORT OF THE WATER BOARD.

OFFICE LOWELL WATER BOARD,
LOWELL, Jan. 14, 1889.

*To the Honorable the City Council of the City of
Lowell:*

In compliance with the requirements of Chapter 39 of the Ordinances, the Lowell Water Board respectfully presents its sixteenth annual report of the receipts and expenditures of the department under its control for the year 1888, together with information and suggestions deemed of importance. We also transmit at this time the annual reports of the Superintendent of the Water Works and of the City Engineer. Appended is a special report of the Water Board upon the subject of mechanical filtration, showing result of investigations pursued during the year in the effort of solving the problem of how to improve the quality of the Merrimack River water as supplied inhabitants of Lowell by the Lowell Water Works.

Number of services disused (disconnected from main).....	21
Number of services in use at present.....	7,755
Number of water meters set in 1888.....	100
Number of water meters set in 1887.....	83
Total number of meters to date.....	1,630
Total number of water takers to date.....	15,500
Estimated population supplied.....	70,000
Number of services shut off for non-payment, 1888,	126
Number of services shut off and since let on and paid,	95
Number of services shut off by error.....	3
Number of services now shut off for non-payment,	28
Number of hydrants set in 1888.....	24
Total number of hydrants in city to date.....	823
Salaries and pay-roll, 1888.	\$ 32,124 25
Salaries and pay-roll, 1887.....	29,801 81
Total charges, all sources, 1888.....	185,012 92
Total charges, all sources, 1887.....	184,395 24
Total charges of 1888 (not including the months of October, November, and December), <i>i. e.</i> , first nine months of year.....	165,968 23
Uncollected charges for same period as above, not including shut-off list for non-payment.....	342 32
Charges previous to Jan. 1, 1888, remaining unset- tled, not including shut-off list.....	284 42
Bonded indebtedness (net) of city on account of the Water Works, Dec. 31, 1888.....	1,191,160 17
Total receipts, all sources, 1888 (including 1887 bal- ance, \$5,384.59).....	188,523 96
Total expenditures, including interest account.....	183,279 73
Balance carried to 1889 account.....	*\$5,244 23

* In making comparisons with figures of previous years it should be borne in mind that at the commencement of 1888 the price charged the city of Lowell for fire hydrants was reduced from an annual charge of \$20 per hydrant to \$12,—a net loss of \$6,084 in available resources in 1888. It will be readily seen that with this, and upon the same footing as in 1887, the balance or amount of receipts over expenditures would be more than \$11,000.

report upon mechanical filtration. The water of this year has been far superior in quality for domestic uses to water furnished for several years. The condition of the river, following an almost unprecedented year's rain-fall, is largely the cause of this most desirable condition of the river water, although the renewed use of the filter basin as an aid in supplying the filter gallery through the summer months, at least, contributed material aid. It is, however, well for your honorable body to understand that the purification of Merrimack River water will never be accomplished by means of natural filtration through the river banks, or by means of artificial beds. Such a system on a very much enlarged scale from the present plant above Pawtucket Falls, and necessarily at a very large additional cost to the city, would undoubtedly supply Lowell with pure water during periods of the year. But it would be worthless during a greater portion of the remainder of the year. That is, when the river is at its maximum state of pureness, you would have the means of making the water purer before it entered the city mains; but when at its maximum foulness, and when filtration is actually necessary, the natural system would be a total failure, and would continue so to be as long as Merrimack River water freezes and the annoying silt exists in its waters. This knowledge has been dearly paid for. Believing this, the Water Board of 1888 turned its attention to mechanical filtration. It is not that

CONSUMPTION AND WASTE OF WATER.

We ask your careful and earnest consideration to what, in our minds, is the most important question that is dealt with in this report, viz.: How shall the present enormous waste of water drawn from our reservoirs be checked? We ask that you consider carefully: First, our present capacity for

disappear on filtration. It is a constituent of common salt, and occurs in waters that run over salt beds, those that are very near the sea-coast, or those that contain or have contained sewage. The Merrimack runs over a bed of granite and gravel, and is, at its sources, remote from the sea; consequently, chlorine here represents sewage. If the chlorine and free ammonia are high in amount, sewage is usually present, and the albuminoid ammonia will be found also high. If the ammonias are high, with but little chlorine, vegetable matter is then the cause of contamination.

Chemists agree that a water supply should not habitually contain more than 0.008 parts free ammonia, 0.015 albuminoid ammonia, and 1.0 or 2.0 of chlorine, to 100,000 parts water. The river at Lowell has a small amount of free ammonia and chlorine, but a slight excess of albuminoid ammonia. I should consider 1.0 or 2.0 parts of chlorine as indicating a dangerous amount of contamination for Merrimack River water, particularly if there was a simultaneous increase of ammonias.

In conclusion, the water at Lowell is still within the limits of safety; but from what is known of its sources of pollution, and the gradual TENDENCY TO INCREASE in all the deleterious elements shown by chemical analysis, it is gradually approaching a point where it can not be used with that degree of safety that is desirable to exist. In the light of our present knowledge, therefore, any efforts to remove the growing impurities from our drinking water are highly commendable.

There is at the present time, among experts, an aversion to recommend the use of water, into which sewage has been poured, for domestic purposes, though the chemical tests do not show a large amount of ammonia and chlorine; and it is hoped that biological tests may throw light on this subject.

LOWELL, Dec. 17, 1888.

pumping; second, the consumption of water during the heated term of summer and the coldest days of winter. It is not enough to say our own is but the experience of other cities. True this is, as we are prepared to show by the following figures recently obtained:

New England Cities.	Popula- tion.	Gallons, Consumption Daily.	Daily Per Capita.	No. Meters.	Services.
Lowell	75,000	4,978,250	66.5	1,630	8,115
Manchester	41,000	2,000,000	50	800	3,300
Salem	28,200	2,100,000	73	135	8,400
Lawrence	40,000	2,520,000	68½	918	10,684
Lynn.	49,500	2,379,000	48.1	271	7,800
New Bedford.....	37,500	3,280,000	88	105	5,495
Portland, et al.....	50,000	6,000,000	120	235	6,700
Providence	123,000	5,375,500	43	7,936	13,564
Springfield	40,000	4,000,000	100	500	4,819
Newton.....	22,000	710,000	32.3	2,500	3,950
Hartford.....	45,000	5,000,000	110	302	10,759*
Worcester.....	82,000	4,007,000	55	7,354	8,704
Fall River.....	64,000	1,590,960	24.86	2,941	4,250
Boston	395,000	37,481,100	76.7	3,534	53,400
Cambridge	70,000	4,137,947	59.11	221	16,044

* Families.

Newton, as will be seen by the foregoing table, consumes per capita 32.3 gallons daily. Their manner of assessment of water rates formerly was the

same as practised in Lowell. By a new ordinance a radical change was made. By its provisions all service pipes supplying other fixtures than ordinary faucets for domestic use must be metered. The meters are furnished, set, maintained, and to be renewed by the department, the water-takers paying an annual rental for their use, and being at no other expense in connection therewith except to protect them against frost or repair all frost damage. This change necessitated the purchase of a large number of meters, and the city purchased one thousand Crowns, the same as used in Lowell. When the following authoritative figures are studied, it will be realized, by the experience of Newton at least, what can be saved by compulsory use of meters.

J. T. Fanning, C. E., in his work on "Water Supply for Cities," gives as the requirements of American cities, as follows:

"For ordinary domestic use, not including hose use, twenty gallons per capita per day.

"For private stables, including carriage-washing, when reckoned on the basis of inhabitants, three gallons per capita per day.

"For commercial and manufacturing purposes, five to fifteen gallons per capita per day.

"For fountains (drinking and ornamental), three to ten gallons per capita per day.

"For fire purposes, one to ten gallons per capita per day.

"For private hose, sprinkling streets and yards, ten gallons per capita per day during the four driest months of the year.

"Waste, to prevent freezing of water in service pipes and house fixtures in Northern cities, ten gallons per capita per day during the three coldest months of the year.

"Waste, by leakage of fixtures and pipes, and use for flushing purposes, from five gallons per capita per day, upwards."

during the year, devoted much thought to the important matter, and have caused to be made a number of tests, to ascertain, if possible, what was a fair basis to build upon for actual consumption per capita. In a tenement block, with seventy occupants, the plumbing first-class in every detail, having a total of 45 taps, including 20 water-closets, the average daily run as read upon the meters, two being used, one to serve as a check upon the other, was 102.5 cubic feet per diem, or 10 U. S. gallons per capita. This, it may be said, is an extreme case. So it is. The families are intelligent, well-meaning people; leakages are common, but are repaired at once; the meter records are looked at twice a week by the one in charge of the property. Near each tap and in every water-closet is this notice:

This water is metered,—that is, paid for by the gallon. Use all the water needed, BUT DO NOT WASTE. Please report to owner if water does not shut off tight after using.

The experiments made with the above property were by one of our officials. It simply shows what care will do. Consider for a moment, that by the City Engineer's records, the average daily consumption of water in 1887 was 4,319,164 gallons, or 63 gallons to each consumer; and that in the winter

to justify extreme measures. There is not the slightest doubt that hundreds of house connections are allowed to run both night and day, as the consumption during the night is almost equal to the amount used during the day, during cold periods. This can only be attributed to wanton carelessness or gross ignorance. A plumber, amenable to no law, runs his pipes as he sees fit, without regard to exposure; work is performed in the cheapest possible manner, and as a result, the owner of a building thinks himself justified in running water to prevent freeze-ups; the consequence being, the city suffers the penalty, paying dearly for its neglect in failing to assume some authority in the direction and supervision of plumbers' work. There are plumbers whose inclination is to do proper work; but competition with others, who are entirely irresponsible, renders a property-holder's chance for honest work not what it should be, nor what it would be, if proper laws were enacted in the interest and for the protection of the property-holder.

Before leaving this subject of waste water, we desire to speak of an evil, the results of which we foresee as one of the disastrous certainties of the present winter. The Board of Health, with commendable zeal, have, during the summer, made war upon that relic of the century past—the privy vault. In many cases, the structures condemned were in back yards or contained in flimsily-constructed out-houses. The property-owner, conforming to the rule

the employ of the department at the time mentioned, the good derived was of doubtful quantity. It seems to this Board, however, that the lack of good results was due more to failure of application of penalties provided by the Ordinances, rather than from any lack in the working of the system. It is our experience that leaks are continually being found upon premises where meters are used, — that is, on property where the waste of water is guarded by the owner for his own interest.* On the other hand, where property uses water under annual-rate charges, and where the amount of water used is of no monetary concern to owner, leaks are not frequently called to notice of Water Department by the owner. Having, as we do, ten rate services where we have one metered service, the fact is at least significant, and warrants suspicions of existing waste.

The situation, then, is just this: when water is metered, the department furnishes inspectors, whose special duty is to see that every thing is tight and in proper order; where property is upon rates, there is practically no oversight. This department has had no access to very many pieces of property for years. We believe that it would be to the advantage of the city were a leak inspector added to the present force, his duty being to inspect every piece of piping and fixtures in the city periodically. For such service we should recommend some individual who has had experience in the Water Department. There is no question that such an inspector, doing

to water consumers. Presuming they are familiar to you, we will state that in our opinion a careful revision would result in a far more equitable system of charges. We believe the prescribed "minimum" charge of \$12 for metered water totally unjust. Its reduction or abolishment would undoubtedly lead to a wider use of meters. Why should you, as a meter owner, pay \$12 annually for less than that money's measure of water, while your neighbor, paying annual rates, can, and in many cases does, actually use, for less charges, two or three times the amount of water you are permitted? The theory has been that the introduction of meters tended to materially lessen the income of the water department. But, if under a system of rate charges, it becomes necessary to pump two, three, and even four millions of gallons for every one million actually used and paid for, the fallacy of the theory becomes apparent. This prepares us to say that there is a course to pursue, as an act of retrenchment, economy, and self-preservation. It is this: Place a meter on every service in Lowell, or if it were practicable, on every tap used in the city, excepting only the ordinary domestic uses which come under the \$6 family rate charge. Such a course would necessitate the city's purchase of a large number of meters, which could be rented at an annual fee as is practised in other cities. It would necessitate an increased force of meter inspectors both for repairs and reading. It would save an enormous quantity of waste. In fact, the problem

The present Board believe in pure water, and water in abundance, but not in the wasteful manner of use that exists in Lowell at the present time. A meter attached to each and every service, with exception previously alluded to, would certainly place all consumers upon a fair and equitable basis. A perfect meter does not exist. Some upon the market we are satisfied are worthless; others, with proper care, will render, with Merrimack River water, very accurate results. We can satisfy the most sceptical person of this fact. We mean to use none but the best, and are ever ready to try new inventions and improvements. At present we are placing the Crown in most cases. We have two others of recent arrival that we are running upon trial, determined, if any improvement or superiority is discovered, Lowell water takers shall be among the first to receive the benefits therefrom. Our experience leads us to declare as our opinion, and in this opinion former members of the Water Board coincide with us, that the time will come when every consumer will use metered water. Water rates can not be reduced so long as the department is compelled to furnish and properly distribute the quantity of water called for during certain periods of the year. Would not a universal meter system check the waste, reduce the running expenses, and postpone the necessity of increase of pipe capacity? Would it not actually reduce the cost of water to consumers? Here is a

the lower reservoir. The broken portions have been made good at a cost of \$1,388.34.

Before it was decided upon what should be done, Engineer E. B. Leavitt, of Cambridgeport, was consulted. He fully endorsed the plan as suggested by Engineer Roberts, and the work was commenced. In doing this repair work important changes have been made. The pump work heretofore performed is now accomplished by seven 9-inch valves seated in the sole-plate, placed at the base of the valve-chamber, re-inforced by ninety-nine 4-inch valves seated in the sides of the valve-chamber. So far the work following the changes is satisfactory, and reflects credit upon Mr. Roberts, who, with his assistants, devised and performed the work. In fact, it is a feature of the Lowell pumping plant. But for lack of time to make the change before winter's work should be upon us, it is not unlikely that we should have taken measures towards the rebuilding of the pump.

The present capacity of the Morris engine plant is 5,000,000 gallons in twenty-four hours. We believe that by an outlay of \$10,000 a new pump could be placed in position, and by speeding up the engine a capacity of 10,000,000 gallons could be obtained. Engineer Leavitt has been consulted upon this matter also. He says there is no doubt of the practicability of the scheme, and that without risk of injury to that noble machine, the Morris engine.

6-inch main running from the intersection of Carter and Gorham Streets, through Gorham and Lincoln Streets. This entire distance has, during the year, been replaced by 12-inch pipe. Two other large fires occurred during the winter at the city's center. It has been said that at both these fires there was a lack of water. The truth of such statements it is not our purpose to dispute. Determined, however, that it was our duty to increase the efficiency of the fire service of the city, after careful investigation, we recommended the introduction of six Lowry hydrants at different points at the city's center. We were met by an objection surprising to us, when we were told upon what grounds the objection was based,—the more, too, on account of the source whence it came. The department caused to be placed at the junction of Bridge and Merrimack Streets such a hydrant as recommended; gave an exhibition of what it was capable of doing before the city's officials, upon the result of which we have since been willing to rest our case. It was then shown, to any fair-minded person, that these hydrants at proper places, located directly on the mains, would furnish an inexhaustible supply of water, and at maximum pressure, no matter what the number of streams emitted. Since that time, on the petition of J. Tyler Stevens and other heavy property owners, one has been set at the intersection of Market and Central Streets. We presume

OF W. E. LIVINGSTON:

26 $\frac{1}{2}$ ~~248~~ tons Pocahontas coal, @ \$5.15.

29 $\frac{3}{4}$ ~~245~~ tons Pocahontas coal, @ \$5.00.

1500 tons Pocahontas coal (887 $\frac{3}{4}$ ~~245~~ delivered), @ \$4.75.

OF MELLERT IRON FOUNDRY:

75 tons 6-inch cast-iron pipe, } @ \$31.60 per ton.
25 tons 8-inch cast-iron pipe, }

3 tons special castings, @ 2 $\frac{1}{2}$ c. per lb.

OF GLOUCESTER IRON WORKS:

115 tons 12-inch cast-iron pipe, @ \$29.93 per ton.

14 pieces special castings, @ \$57.50 per ton.

OF WARREN FOUNDRY:

50 tons 6-inch cast-iron pipe, @ \$30.00 per ton.

50 tons 8-inch cast-iron pipe, @ \$29.60 per ton.

OF R. D. WOOD & Co.:

112 tons 10-inch cast-iron pipe, @ \$26.75.*

CONCLUSION.

Concluding this report, we would acknowledge the faithful services of those in the employ of this department. Perfect harmony exists, so far as we are aware,—each and every one strives for the good of the department, and takes honest pride in his part of the responsibility. We believe the department is a credit to our city. Its efficiency can be increased, nevertheless.

We recommend the following matters to the consideration of the incoming Water Board: The continuation of the filtration investigation, valuable information concerning which is left by us for use; the placing of several Lowry hydrants at the center of the

* Price in Philadelphia.

so long a period, is a matter of surprise to us, as no doubt it will be to property owners in this crowded but valuable section of the city. We would recommend that in the spring of 1889 the first street work performed be the taking up of this 8-inch pipe and placing a 12-inch pipe in its place. The mere mention that such a condition of things exists, should bring speedy remedy.

The time is now near at hand (1890) when the water debt of the city can be refunded at a much lower rate of interest than at present. Of the \$108,045 paid as interest money during the past year, all, but interest amounting to \$3,315, is at the rate of six per cent. or higher. Here is a prospective saving, and an available surplus in sight, at least. It is reasonable for our citizens to expect some direct benefit from this reduction of interest, and the natural direction for it to come would be in the form of reduced water rates. Unless wasteful consumption or unforeseen disaster befalls, compelling the enlargement or repair of the works, and consequent outlay of money, a reduction of water rates will be a likelihood of the immediate future.

MILES F. BRENNAN,
ARNOLD S. WELCH,
HARRY E. SHAW,
E. B. CONANT,
E. D. HOLDEN.

The following Table will Show the Gross Cost of the Water Works Yearly, from the Commencement of the same to Jan. 1, 1889.

Expended in 1870.....	\$ 95,057 00
“ 1871.....	624,151 66
“ 1872.....	560,708 40
“ 1873.....	349,717 87
“ 1874.....	233,370 63
“ 1875.....	275,660 78
“ 1876.....	221,502 24
“ 1877.....	163,814 28
“ 1878.....	158,510 15
“ 1879.....	150,047 82
“ 1880.....	154,391 59
“ 1881.....	231,171 27
“ 1882.....	173,645 92
“ 1883.....	180,280 28
“ 1884.....	175,290 20
“ 1885.....	176,972 56
“ 1886.....	169,105 22
“ 1887.....	176,906 05
“ 1888.....	183,279 73
<hr/>	
Gross cost of works to Jan. 1, 1889.....	\$4,453,583 47
Receipts to Jan. 1, 1889.....	2,070,187 01
<hr/>	
Net cost of works to Jan. 1, 1889.....	<u>\$2,383,396 46</u>

The following Table will Show the Expenditures and Receipts of the Works from 1873 to 1889, exclusive of Interest on the Water Debt.

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873.....	\$188,376 59	\$57,739 48	\$130,637 11	.
1874.....	128,105 63	80,625 65	47,479 98	.
1875.....	170,095 78	94,908 14	75,187 64	
1876.....	115,012 24	98,815 54	16,196 70	
1877.....	53,988 72	100,826 63	.....	\$46,837 91
1878.....	49,900 15	104,142 87	.....	54,242 72
1879.....	42,157 82	110,185 34	.....	68,027 52
1880.....	45,031 59	123,740 49	.....	78,708 90
1881.....	121,601 27	128,053 97	.....	6,452 70
1882.....	64,525 92	140,397 96	.....	75,872 04
1883.....	65,673 23	152,582 99	.....	86,909 76
1884.....	64,982 71	154,437 55	.....	89,454 84
1885.....	64,030 24	157,956 79	.....	93,926 55
1886.....	51,808 52	168,757 53	.....	116,949 01
1887.....	62,236 05	178,234 29	115,998 24
1888.....	75,234 73	183,127 37	107,892 64

SUPERINTENDENT'S REPORT.

EDITOR.

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\$5,384 59

\$183,139 37

\$188,523 96

183,279 73

\$5,244 23

				Total Expenditures.
General Expense.	Mechanical Filter Investiga- tion.	Water Analyses.	Salary President and Supt.	
\$ 68 44	.....	.....	\$166 66	\$ 2,504 91
157 28	.....	\$30 00	166 68	3,599 70
113 91	.....	.....	166 66	4,583 46
61 34	.....	.....	166 68	8,108 52
39 34	.....	.....	166 68	29,165 09
107 61	.....	.....	166 66	35,782 67
94 44	.....	.....	166 68	12,972 94
109 20	.....	40 00	166 68	5,879 88
27 73	\$423 50	20 00	166 66	7,751 01
98 74	.....	30 00	166 66	9,977 94
124 15	70 17	24 00	166 68	46,247 14
76 11	.....	.....	166 66	16,706 47
178 29	\$493 67	\$144 00	\$2,000 00	\$183,279 73

RY.

REPORT OF THE SUPERINTENDENT.

LOWELL, Jan. 1, 1889.

To the Lowell Water Board:

GENTLEMEN,— In accordance with the requirements of the City Ordinances, I herewith submit the Sixteenth Annual Report of the Superintendent of the Lowell Water Works, for the year ending Dec. 31, 1888, and in doing so it gives me great pleasure to report that every branch of the department is in good condition. The total consumption of water for the year is 1,823,089,224 U. S. gallons.

FILTER INLET.

During the past year the filter inlet has been drawn off and cleaned several times, and the wooden box, 24 x 12, which conducted the water from the river to the inlet, has been removed, and a 12-inch cast-iron pipe, forty-eight feet in length, laid to do the work of this box, which was originally sixty feet long; but owing to its exposed condition to floating ice, it was all carried away but about ten feet, which was not long enough to prevent the sand on the river bank from washing into the end of the box and completely clogging it up so as to prevent the passage of any water to the filter. This 12-inch pipe was laid running obliquely down stream, with a 12-inch gate on the bank, and a 2-inch plank placed under the end of the pipe in the river to prevent it from becoming imbedded

necessary to open the river gate one inch, and after a few days it was opened still more, but at no time was this gate opened more than three inches until the filter bed was again cleaned, when a similar result was obtained. Taking into consideration that previous to this time it was always necessary to keep the river gate open at least six inches, it is easy to account in a measure for the improvement in the quality of our water supply the past summer. The inlet was cleaned in all five times, viz: May 28th, June 25th, July 14th, Aug. 13th, and Sept. 14th. Soon after this last date the unusually heavy and almost constant rains had so swollen the river as to cause it to overflow the river banks of the inlet, making it impossible to empty the basin for the purpose of cleaning, and also washing silt, mud, and other matter over the banks, thereby completely preventing any filtration. You can see, by this condition of affairs, that if the river side of this inlet was as high as the other sides, this trouble from high water would not exist, and it could have been cleaned every month up to the present time, and a large percentage of the water in use filtered.

GALLERY AND CONDUIT.

The 30-inch blow-off gate on the conduit was opened May 28th, and allowed to remain so until the next day, during which time the river gate was let on full head, in order to give both the gallery and conduit a thorough blowing-off. Next year, the gallery should be pumped as dry as possible, and then washed and cleaned; also, a careful inspection should be made of the brick conduit.

PUMPING STATION.

The change in the valve chamber of the Morris engine has been completed, under the direction of Engi-

walk has been laid from the house to the driveway, and from Richards Street to the front steps of the house. The driveway, which had been allowed to grow into disuse, was spaded over, regraded, and otherwise improved. The fence on the northerly side of the reservoir lot had to be moved thirty-four feet towards the south, to conform to the lines of Richards Street, — a new street laid out by the government of 1887. The posts of the fence to be moved were found decayed to such an extent that more than one-half of them had to be replaced. Two new gates were set in this fence on Richards Street: one large one for the stable, and a smaller one for the entrance to the house. No repairs have been made on the house this year; and as it is in good condition, none will be needed the coming year. Next year the large fence should be repainted. The stock was purchased this year, with a view of doing this painting, but as it was late in the fall it was deemed advisable to postpone it until next year. The screens in the efflux chamber of the gate house were taken out and cleaned, last month. Mr. Frank Lapoint, the man in charge of the reservoir, has been untiring in his efforts to make the grounds as neat and attractive as possible, as everybody visiting the reservoir can testify. The high-service reservoir grounds are kept closed all the time, and require little attention.

EXTENSIONS.

During the past year there has been laid 17,484 feet of cast-iron pipe, 3,385 feet of which was relaid on Gorham and Lincoln Streets, leaving the total number of feet added to the distributing mains of the city this year 14,099, making 4,983 feet more than was added last year. 2,411 feet were added to the high-service mains of the city this year, which was called for by the opening

pipe was taken up by cutting the pipe every four lengths and hoisting these lengths out of the ditch all connected, then melting the joints in order to separate them. By this means the department was able to save all of the special castings and about three thousand feet of the old pipe, which was laid again in other streets. In connection with this work an additional gate was placed on the 6-inch main at the present terminus of 12-inch line on Gorham Street. This enables the shutting off of the water beyond this point on Gorham Street without interfering with the supply on Lincoln Street.

HYDRANTS.

Twenty-four new hydrants have been added this year, which is more than has been added any one year for the last eight years. Flush hydrants have been changed for post hydrants, as follows: Summer Street, near Gorham; Gorham Street, near Livingston, and Lincoln Street, near Gorham. The Ludlow post hydrant, on Beacon Street, near Sixth, was found entirely broken off above the valve, and was replaced by a Boston post hydrant. Numerous other hydrants have been repaired during the year, mostly cases where the spindle was turned too hard and bent. In the severest part of last winter six hydrants were frozen and had to be thawed. The flush hydrant at the corner of Tanner and Lincoln Streets has been taken out and replaced by a 6-inch post hydrant, with four outlets, and an 8-inch connection, making it the largest post hydrant in the city. As you are aware, two large Lowry hydrants have been set by the department the past year: the first was set at the intersection of the Merrimack and Bridge Street 12-inch main lines, at a point where, if necessary, the water could be supplied directly from the pumps; the second was set

prevent further freezing. If this should occur every winter it would undoubtedly be economy to lower the pipes in these streets. 126 services have been shut off for non-payment; 3 remitted, 95 paid, 28 remain unpaid.

The amount of service pipe laid in 1888 is as follows :

$\frac{5}{8}$ -inch lead pipe.....	5,579 feet.
$\frac{3}{4}$ -inch lead pipe.....	3,172 "
1-inch lead pipe.....	1,189 "
$\frac{3}{4}$ -inch wrought-iron pipe.....	51 "
1-inch wrought-iron pipe.....	753 "
1 $\frac{1}{2}$ -inch wrought-iron pipe.....	135 "
2-inch wrought-iron pipe.....	407 "
2 $\frac{1}{2}$ -inch wrought-iron pipe.....	19 "

Total laid during 1888.....	11,305 "
Amount previously laid.....	287,774 "

Total amount now laid 299,079 "
Or 56 miles 3,399 feet.

Total number of services put in.....	8,115
Total cut off at main.....	384
Total re-connected.....	23
Total now in use.....	7,755

Number and Kind of Services Changed During the Year 1888.

	SIZE OF SERVICE CHANGED FOR.	$\frac{3}{4}$ inch lead.	$\frac{3}{4}$ inch lead.	1 inch lead.	1 inch iron.	1 $\frac{1}{2}$ in. iron.	2 inch iron.	Number Feet.
59	$\frac{3}{4}$ inch iron.....	2230	....	....	....	....	....	2230
81	$\frac{3}{4}$ inch iron.....	....	3322	....	....	....	....	3322
48	$\frac{3}{4}$ inch iron.....	....	....	1661	....	....	....	1661
3	1 inch iron.....	....	....	343	....	....	....	343
3	$\frac{3}{4}$ inch iron.....	....	....	....	198	....	....	198
1	$\frac{3}{4}$ inch iron.....	....	....	....	....	62	....	62
3	$\frac{3}{4}$ inch iron.....	....	....	....	....	....	92	92
6	1 inch iron.....	....	....	....	....	....	83	83
204	Total.....	2230	3322	2004	198	62	175	7991

It will be seen by the above figures that the severe cold of last winter had its effect on the meters as well as the services. More meters were frozen last year than have been frozen altogether since the works were established.

Meters Running Jan. 1, 1889.

SIZE IN INCHES	$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.	1 $\frac{1}{2}$ in.	2 in.	3 in.	4 in.	Motor Register.	Total.
Desper.....	493	149	67	1	....	....	....	....	710
Worthington .	270	25	49	69	25	7	2	....	447
Crown.....	158	154	77	1	6	....	1	....	397
Duplex.....	13	14	9	....	....	....	....	....	36
Ball & Fitts..	17	8	2	1	....	....	....	....	28
Fitts Rotary..	4	1	....	....	....	....	..	....	5
Motor Register	....	....	....	....	....	....	....	6	6
Balance Valve.	....	1	....	....	....	....	....	....	1
Total.....	955	352	204	72	31	7	3	6	1630

LEAKS.

There has been during the past year an unusual number of leaks in service pipes, caused in most instances by men outside the department, who unlawfully take the liberty of turning on water. These men, as a general thing, are either very careless, or they do not understand the way these cocks should be turned, and as a consequence the cocks are wrenched and broken, and a leak is reported, which would not have happened if they called upon the department to do this work. Another cause of leaks is the effect of cinders on wrought-iron pipe. Very frequently a pipe laid through ground made

CONCLUSION.

In conclusion, the department is to be congratulated upon having the services of such an able and efficient clerk as Charles L. Knapp has proved to be the past year. Too much can not be said in his praise, for the ability he has displayed in managing the collections of the department, and for the faithful manner in which he has attended to all the details of the office. I most cordially extend to him my thanks for the assistance he has rendered me, and also I beg leave to return my thanks to your honorable board for your co-operation during the year. In regard to the employees in general, they have done faithful service.

Respectfully submitted,

ROBERT J. THOMAS,

Superintendent.

Low Service — Water Pipes Laid in 1888 (continued).

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.
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Total in miles..... 85.69.

High Service — Water Pipes Laid in 1888.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.
		6-inch.
Fairmount	Southerly to Laurel.....	361
Hanover avenue.....	Northerly from Laurel.....	549
Laurel	Fairmount, easterly.....	1,039
Parkview avenue....	Northerly from Laurel.....	450
	Hydrants	22
	Totals	2,411
	High Service laid previous to 1888.....	16,047
	Total High Service to Jan. 1, 1888.....	18,458

Low Service—List of Stop Gates Set During the Year 1888.

4

4

1

1

1

1

1

1

1

1

1

1

1

1

1

1

2

9

7

4

7

4

1

wedges, 3 yarning irons, 3 lead ladles, 6 crow bars, 4 horses, 5 express wagons, 1 light wagon, 1 single truck, 1 double truck, 4 horse blankets, 4 street horse blankets, 1 buffalo robe, 1 duster, 2 pungs, 1 sleigh, 3 horse brushes, 7 single harnesses, 1 double harness, 12 1-inch lead connections, 4 2-inch, 4 halters, 4 hay forks, 2 manure forks, 2 wagon jacks, 2 wagon wrenches, 2 canvas covers for horses, 3 tons of hay, 2 post hydrants, 15 old style second-hand hydrants, 2 flush hydrants, 12 pipe tongs, 5 Stilson wrenches, 6 monkey wrenches, 4 tapping machines, 20 dippers for drinking fountains, 125 feet block-tin tubing, 1 30-foot extension ladder, 2 24-foot ladders, 2 ratchet cutters, 3 pipe cutters, 20 dies, 2 ratchet die plates, 1 $\frac{3}{4}$ -inch tap, 1 1-inch tap, 1 $1\frac{1}{2}$ -inch tap, 1 2-inch tap, 75 feet block-tin wire, 1 solder pot, 2 solder moulds, 2 charcoal furnaces, 1 naphtha furnace, 5 soldering irons, 19 gate spindles, 2 disks, 10 hydrant spindles, 28 hydrant valves, 10 hoes, 30 hydrant packings for top, 34 for bottom, 68 assorted hydrant packings, 10 packings for 4-inch gate, 12 for 6-inch, 6 for 8-inch, 3 for 12-inch, 1 for 16-inch, 1 map distributing mains, 1 map showing stop-gates, 1 map of Lowell, 1 ton stove coal, 2 portable closets, $\frac{1}{4}$ gross of lamp wicks, 1 blasting battery, 1 desk, 10 lbs. of dualin, 11 S curves, 1 pattern for S curves, 85 lengths of second-hand cement-lined pipe, 2 stone hammers, $\frac{1}{4}$ ton blacksmith coal, 10 lbs. of plumber's solder, 3 paint brushes, 3 paint pots, 1 marlin spike, 6 lights of window glass, 10 lbs. of calking yarn, 20 logs for blasting purposes, 1 10-gallon can, 1 Edison patent pump, 12 feet 4-inch rubber hose, 1 5-gallon can, 2 $\frac{1}{2}$ gallon, 1 $\frac{1}{4}$ gallon, 1 sieve and cover, 1 coal stove, 1 coal hod, 2 brooms, 1 counter scales, 1 platform scales, 1 clock, 2 pipe vises, 2 screw drivers, 2 mallets, 1 foot lathe, 1 lathe dog, 2 bit stocks, 2 bits, 1 2-inch auger, 5 hand saws, 1 washer cutter, 1 bench block, 1 fore plane, 1 set of numbers, 1 directory, 8 galvanized iron pails, 3 chairs, 100 lbs. of scrap leather for washers, 1 iron kettle, 1 hose nozzle, 1 thermometer, 2 lbs. of screws, 1 gallon of castor oil, 1 $1\frac{1}{2}$ -inch Chapman valve, 5 window curtains, 2 lbs. of rosin, 1 pair of snips, 1 tool box, 50 $\frac{5}{8}$ -inch lead connections, 15 1-inch lead connections, 6 hammer handles, 6 1-inch Crown meters, 3 $\frac{3}{4}$ -inch, 10 $\frac{5}{8}$ -inch, 5 tops for 1-inch Crown meters, 3 for $\frac{3}{4}$ -inch, 1 for $\frac{5}{8}$ -inch, 12 tops for Worthington meters, 25 covers, 12 valves and valve seats, 20 spindles for Worthington meters, 12 out and inlet connections for Desper meters, 10 lead connections for Worthington meters, 3 set packing patterns, 1 roll of packing paper, 2 lbs. of sealing wax, $\frac{1}{2}$ box crayons, 1 brass lamp, 1 leather tool bag, 1 pair pliers, 200 brass unions for $\frac{5}{8}$ -inch meters, 6 brass nipples and unions, 6 brass unions for $1\frac{1}{2}$ -inch meters, 6 brass unions for 2-inch meters, 1 pail and tank for testing meters.

Property and Tools at Reservoir.

1 line hose, 1 hose reel, 1 lantern, 1 monkey-wrench, 2 wheelbarrows, 2 long-handle spades, 2 long-handle round-pointed shovels, 1 scythe, 1 snath, 1 wooden rake, 1 iron rake, 1 pitch-fork, 1 lawn-mower, 1 grass hook, 1 square-blade shovel, 5 round-point shovels, 2 picks, 2

ENGINEER'S REPORT.

REPORT OF THE ENGINEER.

OFFICE OF CITY ENGINEER,
LOWELL, MASS., Jan. 1, 1889.

To the Lowell Water Board:

GENTLEMEN, — The undersigned submits the Sixteenth Annual Report of the work done by the pumping engines, and also the records as taken at the Beacon-street Reservoir. The calculations of the duty of the engines were made from the records kept by the late Mr. Lewis Stiles from Jan. 1 to April 5, 1888, and Mr. James P. Roberts from April 5 to Jan. 1, 1889.

All the coal used at the station for pumping, heating, and power for the machine room has been charged to pumping; no deduction has been made, and in the calculation of the duty nothing has been added for friction in the pump.

During the year the Morris engine has run two hundred and seventeen, and the Worthington engine one hundred and nineteen nights. The largest quantity pumped during one day by both engines was 9,429,140 gallons.

The cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is \$8.68, which, added to the average cost of raising the same quantity into the Beacon-street Reservoir, makes the total cost of pumping one million gallons into the high-service reservoir \$15.60.

Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1888.

MONTHS.	No. of days' pump- ing.	Av. No. of hours' pumping per day.		Number of hours' pumping per month.		Number of strokes made per month.	Average No. of strokes made per minute.		Average head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quantity pumped per day, in U. S. galls.	No. gals. of water raised in- to reser- voir per lb. total coal con- sumed.	Duty in lbs., 1 foot high, with 100 lbs. coal, used in pumping on- ly, no deduc- tion for ash- es or clinkers	Duty on to- tal coal con- sumed, no deduction for ashes or clinkers.
		H	M	H	M									
January.....	20	20-22		407-30		244,442	10.00	165.20		75,777,020	3,788,851	410	66,493,333	56,424,026
February.....	17	17-56		305-00		167,155	9.13	167.06		51,818,050	3,048,121	388	63,958,441	54,000,838
March	4	24-00		96-00		49,476	8.59	167.03		15,337,560	3,834,390	390	64,894,567	54,326,488
April	3	22-20		67-00		49,238	12.25	163.08		15,263,780	5,087,927	394	61,159,014	53,577,321
May	11	21-49		240-00		172,814	12.00	163.36		53,572,340	4,870,213	420	65,354,515	57,159,592
June.....	6	21-15		127-30		96,798	12.65	163.95		30,007,380	5,001,230	419	65,184,209	57,183,908
July .....	..	.....		.....		.....	.....	.....		.....	.....	...	.....	.....
August .....	..	.....		.....		.....	.....	.....		.....	.....	...	.....	.....
September	7	19-51		139-00		102,130	12.25	164.49		31,660,300	4,522,900	447	71,150,541	61,215,557
October	20	19-44		394-35		273,513	11.55	162.69		84,789,030	4,239,451	432	68,389,016	58,594,267
November.....	28	21-48		610-15		431,947	11.80	162.84		133,903,570	4,782,270	422	65,960,697	57,307,382
December	19	22-01		418-15		302,510	12.05	163.30		93,778,100	4,935,689	423	66,196,379	57,593,227
Totals and averages..	135	20-47		2,805-05		1,890,023	11.23	164.07		585,907,130	4,340,052	418	66,296,955	57,158,553

Table showing Work done with Worthington High-Service Engine for each Month during the Year 1888.

MONTHS.	No. of days' pump- ing.	No. of hours' pumping per day.	Av. No. of hours' pumping per month.	No. of strokes made per month.	Av. No. of strokes made per minute.	Av. head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Av. quantity pumped per day, in U. S. gallons.	No. gals. wa- ter pumped into reser- voir per lb. of total coal consumed.	Coal, in lbs., used when pumping.
January.....	6	H. M. 14-40	H. M. 88-00	187,920	35.59	78.67	2,630,880	438,480	309	8,500
February.....	4	13-15	53-00	117,259	36.87	78.67	1,641,626	410,406	322	5,100
March	5	12-00	60-00	139,524	38.75	78.67	1,953,336	390,667	315	6,200
April	4	11-19	45-15	97,146	35.78	78.67	1,360,044	340,011	318	4,280
May	5	12-00	60-00	127,690	35.47	78.44	1,787,660	357,532	323	5,540
June	4	17-37	70-30	140,959	33.32	78.67	1,973,426	493,356	346	5,700
July	5	16-48	84-00	173,132	34.35	78.67	2,423,848	484,770	326	7,440
August	5	18-34	92-50	202,143	36.29	78.67	2,830,002	566,000	363	7,800
September	4	14-45	59-00	120,439	34.02	78.09	1,686,146	421,536	351	4,800
October	4	14-52	59-30	106,735	29.89	78.67	1,494,290	373,572	332	4,500
November.....	5	13-54	69-30	140,608	33.72	78.67	1,968,512	393,702	325	6,050
December	5	13-12	66-00	122,764	31.00	78.90	1,718,696	343,739	321	5,350
Totals and averages..	56	14-25	807-35	1,676,319	34.60	78.62	23,468,466	419,080	329	71,260

REPORT
OF THE
LOWELL WATER BOARD
As to Results Following Investigations of
MECHANICAL FILTERS.

*the
of*

1884

MECHANICAL FILTRATION.

CITY OF LOWELL,
IN WATER BOARD, Nov. 15, 1888.

On motion of Mr. Shaw :

THAT WHEREAS, The Lowell Water Board, as a result of investigation upon the subject of filtration, as applied to the treatment of water for the supplies of cities and for domestic uses, is possessed of information of sufficient value to warrant preservation for use of succeeding administrations, it was

Voted, That the clerk of the Water Board, under the direction of the president, at once prepare a report, detailing facts and results reached during such investigation.

REPORT.

During the spring of the present year, a subject of vital moment to the people of the City of Lowell was brought to the attention of the Lowell Water Board, namely : the condition of Merrimack River water, relative to its fitness for domestic use as supplied the residents of Lowell, under the administration of the Lowell Water Works department. The subject resolves itself into two heads or queries, viz. :

1. What is the condition of the water as furnished to-day, and is there any evident deterioration in purity as shown by comparison with the records of preceding years ?

2. Can our water be improved in quality, either by natural or mechanical process ?

It will be noted that no attempt is made by this report to allay any uneasiness in the public mind concerning the condition of the river water. Facts are dealt with, and conclusions must be drawn therefrom. It should be known that each

the river water varies from time to time, as is shown by what has occurred during the fall months of the year. A rain-fall period of unusual length occurred, and the result was at once noticed in the changed appearance of the water, though no harmful traces were apparent. Thus, admitting much of the credit of the water's condition due to nature's assistance, still in no small degree was the renewed use of the filter basin an important aid, permitting some days of almost the entire consumption being drawn from the filter gallery. The rains, however, rendered the condition of the river water so muddy that the filter basin was rendered useless, as it must be until the river becomes clear again, when, after cleansing, it can again be used with success. From the results attained, however, it is established that while the river is free from silt, splendid water can be furnished consumers, the supply being limited only by the capacity of the basin. This result, of itself, is sufficient reason why this valuable, though limited, adjunct to a pure water supply for the City of Lowell should not again be permitted to run to ruin, neglected, and unused. The expense of cleansing monthly, fortnightly, or weekly, is trifling and pays well for the outlay. But from what is thus far written, it is evident that at the critical period when danger lies in the water, if such condition does exist at any time of the year, when the water runs with silt or is sealed by the ice of winter, the basin is of no use. Then of all times it is needed. Thus it will be understood why natural means of filtration under local conditions in our climate must fail to solve the problem, How shall Lowell secure pure water?

These facts confronting the Water Board of 1888, attention was turned to the mechanical filters which have come quite generally into use for mechanical purposes, and to some extent for the filtration of water for the supply of cities of this country and to a very large extent in Europe, where many of the important cities have filtration works of great magnitude and cost.

Before proceeding farther it will be asked, What is a mechanical filter? The filtering process is common in nature. To it is due the clearness of sparkling spring water. This natural system when applicable, on the score of economy, possibly is to

the water becomes very much colored, its "Jersey Lightning" hue being attributed to the character of the source—a cedar swamp. Here, too, the testimony of citizens was favorable to the Hyatt filter. In fact it could not be otherwise, as previous to the introduction of the filters the water could not be used, being, as stated, wholly unfit to drink. Samples of this water (at the time at its maximum purity) before and after filtration were taken, sealed, and expressed to Boston, where they were analyzed, with the following result—the number of parts given being parts of 100,000 :



* Before.

† After.

The above analysis from Professor Norton, it is presumed, is a fair exhibit of what a Hyatt filter will do at the season of the year when the test was made. It is unnecessary to state that in this and other cases the chemist has no knowledge of where water is from, or conditions of taking. Both Somerville and Long Branch plants are located at the pumping station, and require no extra help for their care. At Newark, N. J., at the machine shops of the Newark Filtering Company, an opportunity was offered to examine the parts of the Hyatt filter in detail. This was done with the view of forming some idea as to the probable effect of Merrimack River water upon the iron interior parts, a matter worthy of consideration, following the experience of Lowell with its iron street service pipes. In short, would not the action of Merrimack River water upon the interior in a few years render the entire inner working impracticable? Past experience with iron would indicate such a result

its way in some form or other to the Potomac, are elements to be considered in discovering the defects of our water supply and their remedy. During the summer months, when the rains are few, light, and of short duration, the Potomac is a comparatively clear stream, and the water supplied to the city is of very excellent appearance. But in the autumn, winter, and spring, the period of the year when storms and freshets most prevail, the water becomes more or less impregnated with impurities of all kinds, and the supply as it reaches the city is repulsive in appearance, fills the mind with misgivings as to its wholesomeness, is a drawback on the growth and development of the city, is deleterious to health and morals, and is a source of expense and worry to all householders who are obliged to keep filters for its purification."

The report further says that on investigation the practicability of filtering the water supply of Washington, the inadaptability of the natural infiltration system was soon apparent, and the many disadvantages of the filter bed system were recognized. Filters in which certain chemical and mechanical features are involved have been in use for household, laboratory, and manufacturing purposes for many years, and examination into every form and description of apparatus was made, to see if any were applicable on the larger scale required for a city plant. The result was the conviction that the practical solution of the problem lay in this direction. Following this statement, the Hyatt system is named as the then (1886), in the opinion of the engineers, most desirable plan of filtration. In the report a plan is submitted, the essential features of which are the same as the Lowell party witnessed in actual working at Somerville, N. J., the difference being in the size and capacity of the tanks. The report closes by recommending the appropriation of \$600,000, or as much thereof as needed, to carry out plans submitted. The foregoing must be taken as the endorsement of the United States Government, at that time.

Notwithstanding the favorable and pronounced character of this report, it would appear that no action toward the improvement of Potomac River water has yet been taken by those who have the direction of affairs at Washington. A letter of inquiry

water was not as bad as it looked." Bad as it was, the Jewell filter, with the aid of alum as a coagulant, effected a complete transformation, producing water clear as crystal, although the disagreeable odor remained.

It may be said here that at the request of the Brockton authorities, the Massachusetts State Board of Health have, during the summer, given special attention to the matter of mechanical filtration, and especially to the work accomplished by the Jewell system at Brockton, as well as by one of the Hyatt plants at Holyoke. The Lowell Water Board, determined to avail themselves of all information obtainable, have waited for the report of this acknowledged high and valuable authority. The State Board have also recently made this report, and its special value will be found in what is said regarding the action of chemicals and the traces that are found to remain that would in any way affect the desirability of the water's use. In response to a letter, the following is a reply :

COMMONWEALTH OF MASSACHUSETTS,
STATE BOARD OF HEALTH,
13 Beacon Street, Boston, Oct. 15, 1888.

DEAR SIR,— In reply to your letter of inquiry as to the examination of certain filters named in your letter, I would respectfully reply that the examinations thus far conducted have not reached such a stage as to warrant any definite conclusions upon the subject.

Respectfully yours, SAMUEL W. ABBOTT,
Secretary State Board of Health.

Under date of Nov. 17th, a second request was made, and the following reply returned :

STATE BOARD OF HEALTH,
Chief Engineer's Office, 13 Beacon Street,
BOSTON, MASS., Nov. 20, 1888.

DEAR SIR,— I understand that the report of the state board of health to the city of Brockton has been published in full in the Brockton *Enterprise*. I am now writing for some copies of the paper, and will ask them to send one to you. The board investigated the subject with special reference to the purification of the Brockton water, and have not considered at all the relative merits of different filters.

Very truly yours, F. P. STEARNS,
Chief Engineer.

The Brockton *Enterprise*, of Nov. 10th, contains the State Board of Health report. The portions of interest only to the City of Brockton are omitted in what follows :

filtration. The value of these substances is still further enhanced if, in addition to their chemical action, they act mechanically, by modifying, holding, and carrying down in the process of precipitation any suspended foreign matter, like clay. Many substances have been found useful in this way, principally among which may be mentioned caustic lime, iron in many of its forms, various salts of potassium, alum, carbon, borax, etc. The substance which is most useful in any particular case depends upon the nature of the impurities present, the use to be made of the water, and the magnitude and cost of the work to be done. If the water is to be used for domestic purposes, the substance used must be absolutely and unequivocally free from any deleterious action on the human system under any circumstances within the limits of possibility, and it must be used in such proportion that when its work is completed it will give to the clarified water no chemical reaction or physiological properties. Without entering into a discussion of the various substances, it may be said that, as coadjutants and aids to the purification of water by filtration, alum, lime, and iron seemed possessed of greater advantages than any other materials. It does not necessarily follow, however, that they must be used all the time; in fact, their use would be limited, in all probability [certainly in the case of Lowell water], to those periods of the year when the water is the muddiest. Many exhaustive experiments have been made with alum by eminent chemists, and it has been found that when present in almost infinitesimal quantities, it possesses a wonderful effect on water. In some waters, as actual experiments show, if used in proper proportions, and the water then perfectly filtered, the result will be brighter, clearer, and purer than could be obtained without its use; and furthermore, no trace of the alum can be traced in the filtered water, it having united chemically with the impurities, and being left behind in the interstices of the filtering material, to be removed afterward by the washing of the filter. The use of alum would be very inexpensive, costing in its pure state from one and one-half to two cents per pound. If a small amount of lime-water be added to a natural water containing carbonic acid (and nearly all natural waters do), the result is the

much more water for the operation than by other methods witnessed.

The Warren filter was seen at the Cumberland paper mills, near Portland, Me. Here is to be seen a plant filtering 12,000,000 gallons daily for paper manufacturing uses. To use the words of the Warren people: "The merit of our filter lies first in the thorough system of cleansing, and secondly in the simplicity of construction." The first claim, that of cleansing, is accomplished by the scouring caused by a mechanical rotary rake, and the rinsing by a reversed flow of filtered water. At the time of visit at Portland the fall rains had set in, and the condition of the Presumpscot River was very muddy. Three samples of water were secured and sent to Professor Norton, of Boston, and the result follows, the parts being parts in 100,000:

• Filtered with alum. † Filtered without alum. ‡ Unfiltered water.

It will be understood that the Warren filter at the Cumberland mills, the largest paper plant in the world, is called upon to furnish an enormous quantity of water,—more than double the present daily consumption in Lowell. Viewing this plant, it would seem to verify the fact that what is gained in rapidity of filtration pure and simple is lost in efficiency.

The last filter this report will speak of is that called the Oliphant, after its inventor, William Oliphant. As to its appearance, while the majority of those spoken of resemble an upright boiler, so far as concerns their shells, the Oliphant resembles a horizontal boiler. While in the other filters par-

ing material. Notwithstanding, the filter did a great deal better than I expected it would do, leaving only a very faint tinge in the water." Following this test, the Oliphant people received an order for a 5,000,000-gallon plant for the new Spreckles refinery. At Seneca Falls, City Engineer Evans took the following four samples of water, brought them to Lowell, where they were analyzed by Mr. William P. Atwood, of the Hamilton Manufacturing Company, Lowell. It will be understood that the work of filtering was by the Oliphant filter, and that no chemical was used:

Analysis four samples of water received Nov. 12, 1888. Results in parts per 100,000:

	*Unfiltered.	†Filtered.
Sample No. 1,	unfiltered water.	
Sample No. 2,	filtered water.	
Sample No. 3,	unfiltered water, fire-clay added.	
Sample No. 4,	filtered water, fire-clay added.	
Sample No. 1	has a very faint alkaline reaction.	
Samples Nos. 2	and 4 are neutral.	
Sample No. 3	has a plain alkaline reaction.	

The hardness is expressed as parts per 100,000 of carbonate of lime.

WILLIAM P. ATWOOD.

The foregoing is the result of the Lowell Water Board's investigation of the question of desirability, practicability, and cost (the latter to be referred to later) of providing the water-supply of Lowell with mechanical filters for purifying the water. Certainly, if it is practicable, it is desirable; and if by any







SEVENTEENTH
ANNUAL REPORT
OF THE
LOWELL WATER BOARD,
TO THE
CITY COUNCIL OF THE CITY OF LOWELL, MASS.,
AND THE
REPORTS OF THE SUPERINTENDENT OF WATER WORKS AND
OF THE CITY ENGINEER TO THE WATER
BOARD, FOR 1889.

LOWELL, MASS.:
VOX POPULI PRESS: 180 CENTRAL STREET.
1890.

IN COMMON COUNCIL, Jan. 14, 1890.

Received and ordered on file, in concurrence.

DAVID CHASE, *Clerk.*

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WATER DEPARTMENT, 1889.

WATER BOARD.

ARNOLD S. WELCH, *Prest.*, term expires first Monday in May, 1890.
GEORGE A. SCRIBNER, term expires first Monday in January, 1890.
MILES F. BRENNAN, term expires second Monday in March, 1891.
JOHN STOTT, term expires second Monday in March, 1892.
ARTHUR F. SALMON, term expires second Monday in March, 1893.
CHARLES L. KNAPP, *Secretary and Clerk.*

MILLARD F. WRIGHT, *Superintendent.*

THOMAS F. DOYLE, *Foreman.* ANTHONY F. COGER, *Services.*
WILLIAM JOYCE, *Asst. Foreman.* WALTER P. WILEY, *Meter Repairs.*

LEONARD T. FARRIS, *Service Clerk.*
MARY G. SAWYER, *Book-keeper.*

JAMES P. ROBERTS, *Engineer.* THOS. MCLOUGHLIN, *Asst. Engineer.*

Inspectors.

JOHN J. BANCROFT, THOMAS LENNON,
WILLARD S. KNOWLTON, ROBERT GARDNER, JR.,
JULIAN L. WHITESIDE (resigned Nov. 1).

GEORGE E. WORTHEN, *Leaks and Waste.*
FRANK LAPOINT, *Reservoir.*

REPORT OF THE WATER BOARD.

OFFICE OF LOWELL WATER BOARD,

LOWELL, Jan. 6, 1890.

*To the Honorable the City Council of the City of
Lowell:*

The Lowell Water Board herewith submits to your honorable body its annual report for the year 1889.

The reports of the Superintendent of Water Works and of the City Engineer accompany this report, to which you are respectfully referred for the details of work of construction and that of pumping water, during the year. Appended also is a report made to the Lowell Water Board by City Physician J. Arthur Gage, A. M., M. D., relative to the present condition of Merrimack - river water, together with matter bearing upon the subject of Mechanical Filtration, as a means of improving the quality of water as supplied the inhabitants of Lowell by the Lowell Water Works.

ordinance for two years, retained his seat as member of the 1889 Board.

The above, constituting the Water Board of 1889, held their first meeting on the evening of March 11, 1889, and organized by the choice of Arnold S. Welch as President of the Board.

Millard F. Wright was elected Superintendent of Water Works.

At a subsequent meeting, and in compliance with the ordinance, the Water Board re-elected, for its secretary and clerk, Charles L. Knapp.

THE PAST YEAR'S WORK IN GENERAL.

The work of the year has been completed without mishap, and the operations of all departments have been satisfactorily conducted. It will be seen that the amount of work performed on streets, embraced in extension of mains, new services, renewals of old services, and other work, has been unusually large. This, together with the abundant evidence on every hand of the continued steady growth of the business of the department, is indicated by the following concise summary of principal features, in form of results, with comparison:

	1889.	1888.
Actual charges for 12 months of year, including water, labor, and materials	\$191,594.87	\$185,012.92
Expenditures, as per City Auditor, including payments of interest..	193,535.48	183,279.73

Cost of pumping 1,000,000 gallons:

Morris engine.....	\$6.64	\$6.47
Worthington engine.....	8.40	7.86
Average price of coal:		
Morris engine.....	4.30	4.47
Worthington engine.....	4.35	4.42
Gross debt on account Water Works.....	\$1,828,000.00	
Sinking funds, Jan. 1, 1890.....	683,444.35	
<hr/>		
Bonded indebtedness (net) of City on account of Water Works, Dec. 31, 1889.....	\$1,144,555.65	
Total receipts, all sources, 1889 (including 1888 balance, \$5,244.23).....	194,491.89	
Total expenditures, including interest account...	193,535.48	
<hr/>		
Balance carried to 1890 account.....	\$ 956.41	
Total expenditures on Water Works to Jan. 1, 1890	4,647,118.95	
Total receipts from Water Works to Jan. 1, 1890.....	2,259,434.67	
<hr/>		
Net cost of Water Works to Jan. 1, 1890..	\$2,387,684.28	

The calls for extensions of street mains have been numerous. It has been the policy of the Water Board to grant requests of this kind, whenever the income promised would seem to warrant the work, and in thus acting we have done so always with liberal views as to future possibilities. Such a policy we hold to be right. Every encouragement should be granted that will tend to push the speedy development of Lowell. We offer such encouragement, we believe, when we extend our pipes to and through

Lowell Water Works shows that, in this regard, with the exception of the reservoir accident during 1885, the department has been remarkably fortunate. It can not in justice be attributed to "fortune," however; for while we know not how soon accident may befall us, the fact that it has been delayed thus far redounds to the lasting credit of those men who have preceded us, and whose thorough methods have given us our splendid system, proof as it has been against accidents. The rapid development and increased demands of subsequent years, show errors in judgment, particularly in the small size of street mains in some localities; but in the main, evidences of good work, everywhere of thorough work, are to be found.

IMPERATIVE DEMANDS.

The time has arrived, however, when, in the judgment of the members of the Water Board, additional and necessarily heavy outlays must be made to meet the increased demands of immediate years, as well as to secure absolute safety for the present. It should be known to you that the wells from which the pumps at the Pumping Station draught water are supplied by means of a 30-inch main, extending from the vicinity of Beaver Brook to the pump wells, a distance of about 6630 feet. The limit of this pipe's discharge is 9,000,000 gallons per day. In view of extra demands that have been made at

later. To resume: the duplicating of the two lines of heavy pipe alluded to, will be the first and most important step toward increasing the pumping facilities of the works. It needs not the saying, that within a few years, a third engine must be added to your power, even should the present engines continue capable of full duty.

First, then, the additional mains should be provided as a precaution and a guaranty of safety.

Second, for the reason and in anticipation of the increased pumping your Water Works will soon be required to do, this work should be no longer delayed.

REFUNDING OF WATER DEBT.

On Nov. 1st of the present year, \$1,300,000 of City of Lowell Water Bonds, bearing date of Nov. 1, 1870, become due. Upon this principal the City of Lowell during twenty years will have paid at time of maturity interest at the rate of six per cent., amounting to \$1,560,000. The "day of redemption" is at hand. The City of Lowell need not after the present year pay this enormously high rate of interest. In May, 1891, \$200,000 bonds additional and bearing six per cent. will be payable. All may be refunded at a greatly reduced rate, possibly as low as three and one-half per cent. This will reduce the annual expenditures on account of Water Works very materially. It does not come within the range

owners of the property. In most instances a second visit shows that the remedy has been applied and the evil abated. The official in charge of this work has, since April '23d, visited 5,411 tenements. In this number he has found 243 cases of leaking fixtures, 28 cases of wilful, careless or ignorant running to waste. Of the fixtures found at fault, 98 were water closets. Of these 98 water closets, 79 were direct-pressure closets. This leads us to reiterate what has been many times before declared, that a direct-pressure closet should not be permitted. In no city in the world where proper attention is given to economic methods are they permitted. But so long as the city authorities refuse to assume the control of plumbing work performed in Lowell, they will continue to be found, and being in use, they will, as they ever have, continue to waste an immense volume of water.

The entering upon the last subject emphasizes all that has been said by the Water Board of 1888, urging that the City Council adopt some measure, whereby official oversight shall be had over the work of plumbing performed in Lowell. It is a ruinous policy to permit many of the irresponsible persons now doing alleged plumbing in Lowell to continue their havoc. Your property owners are permitted to be imposed upon, disease is encouraged, your pumping engines are forced to do needless extra labor—all largely attributable to an evil that could

needs of Lowell at the present time. Still it will be borne in mind that there are cities that have undertaken this task and are to-day filtering their supplies, though with, if not doubtful success, not with entire satisfaction. It is not for us to doubt the final accomplishment of successful filtration by mechanical means, but it is a matter calling for most careful study before making even an experimental trial upon our water. We refer your honorable body to the very able and interesting treatment of the subject by City Physician Gage, which accompanies our own report.

Springfield, Mass., on the subject of mechanical filtration, say: "With the limited information we now possess as to the best mode of purifying our city-water supply, we do not feel justified in recommending any plan for filtration, at present. It is presumed, however, that the near future may develop some mode of purifying our water supply that will be effectual and less expensive."

The City of Brockton, Mass., has experimented with a mechanical filter (a Jewell filter using alum), and following their experiments they say: "At present we are unwilling to recommend the expenditure of any more money in this direction [ditching as recommended by the State Board of Health], as we believe that some system of purifying water by filtration will soon be inaugurated, that will be prac-

monia, together with a considerable quantity of free ammonia, is suspicious, but in the absence of free ammonia, the albuminoid ammonia may be allowed to amount to something like .01 part. Above .01 should be regarded as very suspicious, and according to Wanklyn, over .015 part should condemn the water." (Nichols, Water Supply, 1883.)

Yet the same author says in another place: "To fix, however, a definite standard which would apply to all waters, and by which any one can judge of a given water from the numerical results of analysis, is impracticable. Every doubtful water must be considered by itself, with all the light that can be brought to bear upon it." . . .

"If the water is grossly polluted or is of exceptional purity, chemical examination can determine these facts; but in a vast majority of cases, while chemistry may teach something and aid in the decision, it can not teach every thing, and it can not decide. Now it would be very convenient if it were possible to take each item which is made the object of analytical determination and say that a good water may contain so much, and if a water contains more, it is not good.

This is impossible; a certain amount of the same substance might in one case be a sign of fearful contamination, while in another it might indicate only a normal constituent of the water."

Wm. T. Sedgwick, PH. D., of the Massachusetts

joying the privilege of good water. Would that we had the guaranty of as good water for the future!

METERS.

The department has set during the year 155 meters. Of this number 68 are meters set by consumers who had formerly paid for water supply under rate schedule. Of the balance of the number, 73 are new water accounts, and 14 are set under the order of the Water Board. By these figures you will understand that the department has set almost double the number of meters of any previous year in the history of the Water Works. The total number of meter accounts upon our books numbered, Jan. 1, 1,757. By this is meant, meters through which water is measured and paid for at metered rates to the City Treasurer. Besides this number, there are in the city 38 meters, called "private," which are set inside a first meter for convenience of owner of property. There is no question but that hundreds of our property owners can save themselves money by placing a meter upon their premises. There are cases where there would be no saving, but such cases are dwellings with ordinary fixtures, or tenement property of such a character or with plumbing such as to form no fair basis for argument. In earlier days, the meter problem was looked upon as fol-

assured reasonable water-bills and perfect satisfaction. Brookline, Mass., where they have recently adopted a rental-meter system, in their recent report truthfully say: "It is of course too early to speculate upon the effect of this primary step, with either our water waste or revenue. These facts, however, are surely established, namely: that our present system of assessing water rates by fixtures is illusive, inequitable, and fictitious, and that the meter, with its many supposed defects, is the best device known to-day for determining an approximate water consumption and adjusting an equitable charge therefor."

Innumerable are the opinions that might be quoted in sustainment of the meter system. Sandusky, O., say this through their water department: "In short, the only way to do, it seems to us, is to put all consumers on the same basis, that is, make each one pay for what he uses, making the rate low, if you choose, but charging all according to the amount used. The only way to determine what each uses is to measure it. The old cry that meters are not reliable is all moonshine and a thing of the past."

Pawtucket, R. I., possessed of water-works skill recognized everywhere, say: "While the question of the general use of meters has been held with difference of opinion in the past, we have advocated meter measurement first, last, and all the time.

Cities.	Family Rate.	Pan Closet.	Bath Tub.	Wash Bowl.	Wash Tub.	Horse and car- riage, with use of hose.	Cow.	Hose.	Total.
Meriden, Conn.....	\$ 5 00	\$ 3 00	\$ 2 00	.....	.....	\$ 3 00	\$ 1 00	\$ 3 00	\$17 00
Wallingford, Conn..	5 00	3 00	3 00	.....	.....	3 00	1 00	3 00	18 00
New London, Conn..	5 00	3 00	3 00	.....	.....	2 00	2 00	2 50	17 50
Yonkers, N. Y.....	10 00	2 00	3 00	1 25	2 00	2 00	2 00	2 50	23 75
New Bedford, Mass..	2 50	2 50	2 50	1 25	.....	4 50	50	2 50	16 25
*Boston, Mass.....	7 00	2 50	2 50	.....	.....	6 00	.....	5 00	23 00
Pawtucket, R. I.....	7 50	.....	.....	.....	.....	4 00	1 00	6 00	18 50
New Haven, Conn...	6 00	3 00	3 00	.....	.....	6 00	1 00	3 00	22 00
Mass.	6 00	■ ■ ■	3 00	.....	1 00	2 00	1 00	5 00	19 00
Portland, Maine.....	13 00	6 00	5 00	2 00	3 00	8 00	.....	5 00	42 00
Columbus, Ohio.....	9 00	3 00	3 00	.....	.....	3 50	.....	5 00	23 50
Lawrence, Mass.....	6 00	4 00	■ ■ ■	■ ■ ■	2 00	3 00	1 50	2 50	23 00
Lynn, Mass.....	6 00	5 00	5 00	2 00	2 00	5 00	1 50	3 00	29 50
Fitchburg, Mass. ...	6 00	5 00	5 00	2 00	1 00	8 00	2 00	5 00	34 00
Newton, Mass.....	6 00	5 00	5 00	.....	.....	10 00	1 50	5 00	33 50
Cambridge, Mass....	7 00	6 00	■ ■ ■	2 50	2 50	5 00	2 00	■ ■ ■	41 00
Providence, R. I.....	6 00	5 00	5 00	.....	.....	4 00	1 00	5 00	30 00
Taunton, Mass.....	5 00	5 00	3 00	2 00	2 00	4 00	1 50	5 00	27 50
Lowell, Mass.....	6 00	4 00	3 00	.....	1 ■ ■	4 00	2 00	3 00	23 00
Fall River, Mass....	5 00	■ ■ ■	5 00	2 50	2 50	4 00	1 00	6 00	31 00
Brooklyn, N. Y.....	16 00	2 00	.....	.....	.....	5 00	75	5 50	29 25
Albany, N. Y.	18 00	■ ■ ■	.....	.....	.....	3 00	.....	■ ■ ■	31 00
Buffalo, N. Y.....	20 00	8 00	5 00	.....	.....	4 00	1 50	6 00	44 50
Niagara Falls, N. Y..	9 00	3 00	3 00	.....	.....	3 00	1 50	6 00	25 50
Detroit, Mich.....	7 00	3 00	2 00	.....	.....	4 00	1 00	3 00	20 00
Cincinnati, Ohio.....	14 00	3 00	5 00	1 00	.....	5 00	.....	4 00	33 00
Cleveland, Ohio.....	10 00	5 00	2 50	.....	.....	2 50	.....	1 50	■ ■ ■
Chicago, Ill.	19 00	5 00	3 00	8 25	.....	4 00	.....	■ ■ ■	43 25
Philadelphia, Pa....	8 75	2 00	3 00	1 00	1 00	3 00	.....	9 00	27 75
Salem, Mass.....	3 50	5 00	5 00	1 50	.....	6 00	1 00	3 00	25 00
Springfield, Mass....	■ ■ ■	4 00	4 00	.....	.....	4 00	■ ■ ■	■ ■ ■	27 00
Concord, N. H.....	6 00	3 00	3 00	1 00	.....	2 00	1 00	3 00	19 00
Hartford, Conn.....	5 00	3 00	1 00	.....	.....	4 00	1 00	5 00	19 00

* City of Boston reduced rate Jan. 1, 1920, seven per cent.

the public eye, speaks for itself, and in a manner, we think, that reflects no discredit to the City.

PUMPING STATION.

The pumping station has been under the charge of Mr. J. P. Roberts, during the year. Records kept by the engineer show the total amount of water pumped into the reservoir during 1889 was 1,691,804,700 U. S. gallons, against 1,822,042,490 gallons in 1888, a decrease of 130,237,790 gallons in 1889, or a daily consumption average of 4,654,259 gallons in 1889, against 4,978,258 in 1888.

The total consumption of coal at the pumping station for all purposes amounts to 1558⁸⁸⁰/₁₀₀₀ tons against 1800⁷⁷⁰/₁₀₀₀ tons in 1888. The engineer accounts for this saving of coal by the fact that he has been able to run the Morris engine nearly the entire year; the only accident that happened being the breaking of keys during the month of December. Of the entire pumping, the Morris engine performed more than 95 per cent. of the work. This is an admirable showing and reflects credit upon the engineer and his assistants, for their care and watchfulness, night and day throughout the year.

COAL AND IRON-PIPE CONTRACTS.

In the regular routine of our business the heaviest purchases are for coal and cast-iron pipe.

the question of whether or no it is wisest for the department to exist in a hand-to-mouth fashion, or to carry a supply of material sufficient to meet any and all possible calls, the fact exists, that what was over-bought during the year has already proved a good investment. It is sufficient to say that we could not buy this same pipe to-day for less than from \$34 to \$35 per ton. By another summer it is not unlikely it will be even higher. Such fact stated, we think sufficient answer to criticism concerning the business policy of the department, in this direction.

ARNOLD S. WELCH,
ARTHUR F. SALMON,
MILES F. BRENNAN,
JOHN STOTT,
GEO. A. SCRIBNER.

Bacheller, Dumas & Co.....	251 60
Badger, F. S.....	1 75
Barker Manufacturing Co.....	2,637 59
Boston & Maine Railroad.....	670 75
Boutwell Brothers.....	47 59
Bolton, T. M., & Co.....	10 15
Boston & Lowell Railroad.....	3 85
Bartlett & Dow.....	3 10
Badger & Kimball.....	3 50
Builder's Iron Co.....	702 45
Burnham, Forrest & Davis.....	97 94
Brown, B. G.....	46 25
Brigham, C. W.....	2 75
Bean, C. S.....	14 82
Cahill Brothers.....	7 75
Cahill, Owen.....	19 20
Carleton & Hovey.....	6 75
Church & Son.....	55 02
Coburn, C. B., & Co.....	481 78

Paid for Sundries :

Coggeshall, F. P.....	\$ 4 20
Cole & Nichols	9 42
Costello & Co.....	2,669 93
City: Appropriation Roads and Bridges	277 09
Appropriation Public Buildings.....	56 83
Appropriation Sewers	25 00
Appropriation Fire Department.....	30 00
Appropriation Reserved Fund.....	173 62
Clark, Thomas	8 95
Chapman Valve Co.....	898 28
Cameron, Amberg & Co.....	42 90
Clapp, Charles	3 00
Coburn, C. G.....	13 50
Campbell & Hanscom	14 70
Citizen Newspaper Co.....	24 00
Cheney, C. J.....	1 10
Critchett, James.....	2 00
Conant, C. P.....	121 90
Charon, Moses.....	21 75
Desper, W. E., & Co.....	280 88
Donovan, J. J., & Co.....	30 90
Derby & Co	1 50
Draper & Co.....	59 90
Donaldson Iron Co.....	7,156 38
Duckworth, John.....	5 15
Duren, T. E.....	20 00
Davis & Sargent.....	14 69
Engineering Record	6 00
Ebert, H. F	23 15
Erskine, Charles M.....	16 43
Farrell & Conaton	82 93
Foye, W. P.....	47 69
Fay Brothers & Hosford.....	9 82
French & Puffer.....	8 25
Gage, Daniel.....	49 50
Gates & Sons.....	11 46
Glover, W. B.....	4 60
Goulding, Robert.....	4 10
Globe Gas Light Co.....	4 00

Paid for Sundries:

Proprietors Locks and Canals.....	\$ 51 68
Pevey Brothers	95 02
Perrin, Seamans & Co.....	97 00
Parker, W. H., & Son.....	3 50
Pratt, A., & Co.....	17 29
Pendexter & Farley.....	22 50
Page Belting Co.....	100 00
Ripley, Joseph.....	5 00
Reynolds, T. J.....	18 40
Rollins, F. E.....	15 19
Rice & Co.....	35 70
Scannell & Wholey.....	816 86
Smith, A. L.....	25 76
Smith, M. B.....	115 35
Shattuck, H. B.....	46 50
Staples Brothers.....	1,378 97
Stewart, J. W., & Co.....	75
Smith, James	7 90
Sheppard & Sons	19 55
Sherman, W. A.....	2 00
Snow, R. D.....	4 50
Swann & Smith.....	35 00
Sawyer Carriage Co.....	195 35
Smith, S. C. & G. H.....	1 68
Smith, E. A. & A. T.....	123 31
Stanton & Thurston.....	6 75
Sparks, J. H.....	9 50
Taylor, F., Co.....	323 19
Taylor, T. W.....	205 00
Talbot Chemical Co.....	2 80
Thompson, C. C.....	4 90
Union Iron Foundry Co.....	147 14
Vox Populi Press.....	145 25
Western Union Telegraph Co.....	4 67
Wilder, H. H., & Co.....	198 63
Whittier Machine Co.....	263 40
Walworth Manufacturing Co.....	111 58
Worthington, H. R.....	573 65
Wood, E. N., & Son.....	78 03

The following Table will Show the Expenditures and Receipts of the Works from 1873 to 1890, exclusive of Interest on the Water Debt.

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873.....	\$188,376 59	\$ 57,739 48	\$130,637 11	
1874.....	128,105 63	80,625 65	47,479 98	
1875.....	170,095 78	94,908 14	75,187 64	
1876.....	115,012 24	98,815 54	16,196 70	
1877.....	53,988 72	100,826 63	.....	\$ 46,837 91
1878.....	49,900 15	104,142 87	.....	54,242 72
1879.....	42,157 82	110,185 34	.....	68,027 52
1880.....	45,031 59	123,740 49	.....	78,708 90
1881.....	121,601 27	128,053 97	.....	6,452 70
1882.....	64,525 92	140,397 96	.....	75,872 04
1883.....	65,673 23	152,582 99	.....	86,909 76
1884.....	64,982 71	154,437 55	.....	89,454 84
1885.....	64,030 24	157,956 79	.....	93,926 55
1886.....	51,808 52	168,757 53	.....	116,949 01
1887.....	62,236 05	178,234 29	.....	115,998 24
1888.....	75,234 73	183,127 37	.....	107,892 64
1889.....	80,554 68	189,247 66	.....	108,692 98

MONTHS.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
January.....	\$ 233 37	\$ 271 52	\$ 472 76	\$ 702 05	\$ 410 21	\$ 427 66	\$ 454 33	\$ 420 32
February.....	139 22	136 06	347 66	352 90	439 68	439 98	343 06	495 71
March	90,856 37	94,956 65	98,692 13	102,961 30	104,537 77	111,281 68	110,812 26	114,110 39
April	403 64	263 10	351 73	439 64	1,355 01	773 67	536 02	1,219 74
May	1,191 41	984 84	1,495 90	1,062 34	1,760 48	2,057 80	1,750 52	2,618 47
June	16,401 62	17,757 44	18,709 27	21,203 61	23,768 43	23,017 09	26,090 68	25,322 78
July	959 80	1,059 37	899 21	1,053 36	1,434 99	2,383 37	1,781 40	1,328 39
August	634 40	902 76	984 17	828 40	1,173 44	927 65	1,072 41	1,273 06
September	10,904 30	12,467 32	12,939 94	13,452 97	16,105 05	18,397 55	16,773 25	16,288 39
October	552 27	941 81	738 12	697 87	783 29	1,108 16	1,414 52	1,107 60
November.....	378 97	1,615 65	693 41	477 10	686 02	683 55	937 19	874 11
December	10,848 08	12,512 70	12,544 55	12,617 45	12,825 41	15,927 35	14,476 76	15,096 53
Totals	\$133,503 45	\$143,869 22	\$148,028 85	\$155,848 98	\$165,279 78	\$177,425 51	\$176,442 40	\$180,155 49
Less abatements to date.....	2,490 50	3,094 15	4,314 79	3,946 34	2,991 18	2,367 70	2,794 87	†5,414 91
Net amounts	\$131,012 95	\$140,775 07	\$144,614 06	\$151,902 64	\$162,288 60	\$175,057 81	\$173,647 53*	\$174,740 58

* A reduction of \$6,084.00 is accountable, owing to reduction of annual charge for fire hydrants.
† Abatements represent errors in making charges, clerical errors, abatements voted by Water Board, etc. A large item is that of abated rates as charged in annual account, and abated on account of meters set during the year.

1889 Water Works Account

Balance undrawn Jan. 1, 1889...

Received into the treasury on

WATER WORKS:

From Sundry persons for water
 Sundry persons for water
 Sundry persons for water
 Sundry persons for water
 Sundry persons for water

Total expenditures in

Balance undrawn Jan.

MAINTENANCE.

Labor and general expense account.	Labor.	Office salaries.
\$259 25	\$334 00	\$354 15
144 00	112 50	283 44
199 87	217 25	354 30
53 00	182 99	283 44
34 12	444 36	235 44
14 75	597 61	294 30
17 00	763 71	243 44
.....	626 38	304 30
.....	497 30	243 44
25 00	433 62	243 44
.....	607 46	304 30
.....	248 43	182 50
\$746 99	\$5,065 61	\$3,326 50

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SUPERINTENDENT'S REPORT.

REPORT OF THE SUPERINTENDENT.

LOWELL, MASS., Jan. 1, 1890.

To the President and Members of the Lowell Water Board:

GENTLEMEN, — I herewith present the seventeenth annual report of the Superintendent of the Lowell Water Works, as required by the City Ordinance, for the municipal year ending Dec. 31, 1889.

SUPPLY MAINS.

Work was commenced in this department on the 24th of March, and continued till the 14th of November. About eighteen to twenty men have been employed. There has been laid 20,510 feet cast-iron, which is a much larger number in feet than has been laid since 1877, when, in fact, the works were hardly completed. You will notice in the table that there has been very little pipe laid, smaller than 6-in. in diameter. I do not deem it advisable to lay smaller than 6-in., for it is of no practical use for fire purposes.

The longest line laid this year was on Pine street, which was 2048 feet in length. The people living on this

feet of wrought-iron pipe has been laid, making a total of 21,788 feet laid in 1889, or $4\frac{668}{787}$ miles.

It would be useless for me to say that there will not be many applications for extensions of mains the coming year, for the City is extending toward the City lines in all directions. And of course all will want City water.

NEW SERVICES.

356 new services have been laid; a larger number has not been laid since 1882.

11,587 feet have been laid, against 11,305 feet last year, which indicates the rapid growth of the City. But three iron services have been added, the past year. The amount of service pipe laid in 1889, is as follows:

$\frac{5}{8}$ -inch lead pipe.....	4,338 feet.
$\frac{3}{4}$ -inch lead pipe.....	4,894 "
1-inch lead pipe.....	1,615 "
1-inch iron pipe.....	354 "
$1\frac{1}{2}$ -inch iron pipe.....	43 "
2-inch iron pipe.....	343 "
	<hr/>
Total laid during 1889.....	11,587 "
Amount previously laid.....	299,079 "
	<hr/>
Total amount now laid.....	310,666 "

Or 58 miles 4,426 feet.

Total number of services put in... ..	8,471
Total cut off main.....	447
Total re-connected.....	26
Total now in use.....	8,050

Number and Kind of Services Changed During the Year 1889.

SIZE OF SERVICE CHANGED FOR.		$\frac{1}{2}$ inch lead.	$\frac{3}{4}$ inch lead.	1 inch lead.	1 $\frac{1}{2}$ in. iron.	2 inch iron.	No. of feet.
27	$\frac{3}{4}$ -inch iron.....	1057	....	....	....	....	1057
140	$\frac{3}{4}$ -inch iron.....	....	4922	....	....	....	4922
60	$\frac{3}{4}$ -inch iron.....	....	....	2268	....	....	2268
8	1-inch iron.....	....	....	370	....	....	....
1	$\frac{3}{4}$ -inch iron.....	....	....	....	47	....	47
2	1-inch iron.....	....	....	....	....	90	90
1	1-inch iron.....	....	44	....	....	....	44
239	Total.....	1057	4966	2638	47	90	8798

Twenty-one new post hydrants have been set, all of the Chapman pattern. Two flush-hydrants have been taken out, and post-hydrants set in their place.

Quite a number of hydrants reported by the Chief of the Fire Department as being out of repair have been attended to. The main cause of their being out of repair, which we all know is by the improper handling by persons in the employ of the sewer and other departments. I would recommend to the Board, that there should be an employe of this department sent upon application from the Sewer Department in all cases where it is necessary to open a hydrant for flushing or other purposes; by so doing, all the water used could be metered, and it would also place the damage done to hydrants where it belongs; by doing this the Water Department will get what rightfully belongs to it, an accurate account of water used.

We have taken out four old wooden hydrant-boxes, and replaced them by four iron boxes which we had on

services in use. The leaks have been generally caused by the breaking of the old "goose-neck."

RESERVOIR.

The high-service reservoir has required but little attention the past year, but another year the fence will need some repair.

Not so with the Beacon-street reservoir. Practically a new fence has been built on three sides, which was very much needed. The fence and gate-house have been painted two coats; the stable at the keeper's house has been slightly changed, and the same received one coat of paint. There is a space of about four feet of grass-ground between the fence and the top of the embankment which should be concreted, to further the cleanliness, which the present Board has worked so hard to bring about. The concreting will prevent the dead grass and earth from finding their way into the water.

PUMPING STATION.

The pumping station has received two coats of paint; a guard has been placed about the Worthington pump as a precaution against accident to visitors.

The Morris engine pump has been run steadily until December 16th, when a slight break occasioned the starting of the Worthington for a few days, while the repairs were being made. The old Jacket boiler that has been in use since 1876 has given out, and a new one ordered to take its place at a cost of \$175. The pump-well has been cleaned out five times; each time more or less sediment was found.

1,691,804,700 gallons of water were forced into the low-service reservoir, against 1,822,042,490 gallons in 1888, a

gauge recorded 47 lbs., and before the fire department would have had occasion to use water, the pressure would have been up to the 60 lbs.

FILTER GALLERY.

The filtering gallery has been thoroughly cleaned on July 29, 30, and 31. The pump was idle; all the water was drained from the gallery, but about eighteen inches. A large 8-inch centrifugal pump was got in Boston, with boiler and engine attached, placed at the man-hole near the inlet-basin, most of the water was pumped out; twenty men entered at the upper man-hole, and with brooms washed the top and both sides as clean as possible, keeping the bottom agitated all the time the pump was running. We were very much surprised to find so little silt and accumulations on the bottom. This work has been done but once since the construction of the works.

On the bottom of the gallery were found quite a number of springs, the temperature of which was found to be twenty-five degrees colder than the river water.

CONDUIT.

The brick conduit has received the same treatment as the gallery.

BEAVER BROOK CROSSING.

The 30-inch crossing under Beaver Brook has been blown out three times during the summer. There has been some anxiety expressed that there might be more or less sediment lying in the bottom of the pipe. On October 26th, all the water that could be, was drawn off. Then the services of a steam fire engine were called to pump out that remaining in. A man with a rope around

The Board has visited the shop on Broadway, and of course you could not but notice the condition of the same. I can hardly see how they could do the amount of business that is required of them; every thing was thrown into boxes; if an article of repairs was needed, a man could hunt and, by chance, might possibly find what he wanted; but when the repairs that are now going on are finished, I am in hopes to show to the Board that the business should have been systemized years ago, and in my opinion save a large amount of money for the department, by holding somebody responsible for the material delivered to the meter, construction, or service departments.

Six-inch fire services have been laid for Otis Allen & Son on Mt. Vernon Street, Fay Brothers & Hosford for new theatre on Central Street, a 4-inch fire service for G. H. Marston's new block on Middlesex Street, and for the new Palmer-street engine house; also at elevator building for J. G. Sherburne.

An old flush hydrant was taken out from the yard of the Shaw Stocking Company, and a new post hydrant set in its place.

A new two-way post hydrant was set over at the Merrimack Woolen Mills, for that company.

The consumers of water are just waking up to the idea that the proper way to use water is to meter it, so as to pay for only what is used, and the fact that the present Board places meters at the actual cost, has caused a larger number of meters to have been set than in any other year. The number of new meters set has been 155. The table below shows the number of meters, both regular and private, that are running at the present time:

Private Meters Running Jan. 1, 1890.

SIZE IN INCHES.	$\frac{1}{2}$ inch.	$\frac{3}{4}$ inch.	1 inch.	2 inch.	Total.
Desper	1	3	1	..	5
Worthington .....	..	..	1	1	2
Crown	7	13	1	..	21
Duplex	1	..	..	..	1
Frost	2	1	..	..	3
Thomson	4	1	..	..	5
Hersey	1	..	..	..	1
Total	16	18	3	1	38

Two 2-inch stand pipes have been set for street watering purposes, one on Nesmith Street, and one on Highland Street.

The question of better protection against fire is always before the people of the city. I see, in studying over the system of mains, that the center of the city is not, in my opinion, as well cared for as it should be. The fact exists that there is but a 6-inch main in Central Street, from Merrimack to Market Streets, where it comes to a dead end. The same should be said of Middle Street, where a 6-inch main runs about 350 feet, then an 8-inch the remainder of the way. Therefore, I would recommend to the Board, that a 16-inch (at least) be laid in Central Street, connecting at Market Street, and a 12-inch (at least) in Middle Street, connecting with Shattuck Street.

One of the large 30-inch drinking fountains has been changed from Bridge to First Streets, in front of land owned by the city, which change the people of Centralville are very much pleased with.

In conclusion, I desire to express my obligation to the President and members of the Water Board. Also to Mr. Knapp, the Clerk, and all other employes of the department, who have worked to make the department as efficient as it is to-day. Taken in all it has been the most prosperous year of the Lowell Water Works.

Most respectfully submitted,

MILLARD F. WRIGHT,

Superintendent.

Low Service — Water Pipes Laid in 1889 (continued).

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.
	<i>Brought forward</i>	
†Middlesex ...	Garnet and King.....	
Midland.....	Westerly of Chelmsford.....	
Nesmith	Extended southerly to Rogers...	
New Walker..	From D southerly.....	
Nicollette av.	Extended from Stevens westerly	
Parker	From Pine southerly	
Payton	Extended southerly of Plain.....	
Perry	From Pond southerly.....	
Perry	Extended southerly towards Sher man	
Perry	From Sherman southerly.....	
Pine	Oakland and Westford.....	
Pine Hill.....	From Kinsman north-westerly..	
†Pond.....	Concord and Perry.....	
Princeton	Windsor and Livingston av.....	
Puffer's Court	From Jewett westerly.....	
Rogers	From Nesmith south-easterly....	
School	Rock and N. & L. R. R.....	
Sherman	Concord and Perry.....	
Sherman . .	Huntington and Hanks.....	
So. Walker. .	Liberty and Mason.....	
So. Walker...	From D northerly.....	
So. Loring....	From D northerly	
Stevens.....	Extended southerly to Forrest...	
Third av.....	From White south-westerly.....	
Twelfth	From Wachusett easterly.....	
Washington ..	Extended southerly.....	
Wachusett....	From Twelfth northerly....	
Ware	Extended southerly.....	
Walden.....	Extended westerly towards Pa ker.....	
White	From Riverside north-westerly..	
Whitney av...	From Beacon westerly.....	
	<i>Carried forward</i>	

Low Service — List of Stop Gates Set During the Year 1889.

STREET.	LOCATION.
Congress	11 ft. north of south line of Congress, 1 ft. east of west line of Gorham.....
Dutton.....	3.5 ft. north-westerly of south-easterly line of Dutton, 33.5 ft. north-easterly of passage-way opposite L. M. S. office.....
Eighteenth ...	13 ft. south of north line of Eighteenth, on west line of Beacon.....
Foster.....	13 ft. west of east line of Foster, on north line of Pine.....
Foster	7 ft. west of east line of Foster, 2.5 ft. north of north line of Westford.....
Forrest.....	12 ft. south of north line of Forrest, on east line of Stevens.....
Hanks	13.3 ft. west of east line of Hanks, on south line of Sherman..
Hanks.....	15 ft. west of east line of Hanks, 10 feet north of north line of Rogers.....
Harvard.....	14.5 ft. west of east line of Harvard, 4 ft. south of south line of Middlesex.....
*Howe	12.5 feet east of west line of Howe, 1 ft. south of south line of E. Merrimac.....
Mariborough..	12 ft. west of east line of Mariborough, 2 ft. north of north line of Pine.....
New Walker..	14 ft. west of east line of So. Walker, on south line of D.....
†Middlesex ...	17 ft. north of south line of Middlesex, 2 ft. west of west line of Garnet.....
Middlesex	13 ft. south of north line of Middlesex, 15.5 ft. west of east line of Harvard.....
Nesmith.....	15 ft. west of east line of Nesmith, opposite Rogers.....
Nicolette av..	12 ft. south of north line of Nicolette, 3 ft. west of west line of Stevens.....
Parker.....	11.5 ft. west of east line of Parker, on southerly line of Pine.....
Pine.....	15.5 ft. south of northerly line of Pine, 37 ft. east of east line of Mariborough.....
Pond.	20 ft. south of north line of Pond, on west line of Concord.....
River.....	16.5 ft. west of east line of River, 24 ft. north-westerly of south-east line of Aiken
Sherman	12 ft. south of north line of Sherman, on west line of Concord
So. Loring....	12 ft. east of west line of So. Loring, on north line of D.....

Low Service — List of Hydrants Set During the Year 1889.

STREET.	LOCATION.
D	North side, opposite New Walker st.
Foster.....	Easterly side, 141 ft. northerly of Pine st.
Forrest.....	Northerly side, 799 ft. easterly of Stevens st.
Fruit	Southerly side, 50 ft. westerly of Plain st.
Hanover.....	South-easterly side, 94 ft. northerly of Moody st.
Howe	West side, near the Belvidere Woolen Mills' yard.
Harvard.....	North-east corner of Troy st.
Marlborough	Easterly side, 423 ft. northerly of Pine st.
Perry	West side, 311 feet southerly of Pond st.
Pine.....	Northerly side, 527 ft. westerly of Foster st.
Pine.....	Northerly side, 584 ft. southerly of Westford st.
Rogers	Easterly side, 868 ft. southerly of Nesmith st.
School	Easterly side, 153 ft. north of the N. & L. R. R.
So. Walker.....	North-east corner of Liberty st.
So. Walker.....	Near north-east corner of Mason st.
White	North-westerly side, 28 ft. north-easterly of angle in street.
Wilder	West side, about 120 ft. north of B st.
Whitney av.....	South side, 147 ft. westerly of Beacon st.
Worthen.....	North-westerly side, opp. passage-way leading to L. M. S. yard.
Worthen.....	North-westerly side, 29 ft. north-easterly of Kitson st.
High Service.	
Parkview av.....	West side, opp. the residence of Henry J. Moulton.

ENGINEER'S REPORT.

REPORT OF THE ENGINEER.

OFFICE OF CITY ENGINEER,
LOWELL, MASS., Jan. 1, 1890.

To the Lowell Water Board:

Gentlemen,— The following is the Seventeenth Annual Report of the work done by the pumping engines, and also the records as taken at the Beacon-street reservoir. The calculations of the duty of the engines were made from records kept by Mr. James P. Roberts, the engineer in charge at the pumping station. All the coal used for heating, pumping, and power for the repair room has been charged to pumping; no deduction has been made, and nothing added, for friction in the pump.

The largest quantity pumped during one day by both engines was 9,229,840 gallons. 130,237,790 gallons less were pumped this year than last. Probably this is partly due to the mild winter. During the year the Morris engine has run two hundred and seventy-two, and the Worthington engine seventeen nights. The cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is \$9.19, which added to the average cost of raising the same quantity into the Beacon-street reservoir, makes the total cost of pumping one million gallons into the high-service reservoir, \$15.91.

Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1889.

MONTHS.	No. of days' pump- ing.	Av. No. of hours' pumping per day.	Number of hours' pumping per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quantity pumped per day, in U. S. galls.	No. galls. of water raised in- to reser- voir per lb. total coal con- sumed.	Duty in lbs., 1 foot high, coal, used in pumping on- ly, no deduc- tion for ashes or clinkers.	Duty on to- tal coal con- sumed, no deduction for ashes or clinkers.
January	3	14-30	43-30	33,589	12.87	163.91	10,412,590	3,470,863	425	67,732,718	58,056,613
February .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
March .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
April .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
May .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
June	2	8-15	16-30	11,233	11.35	163.08	3,482,230	1,741,115	446	76,334,333	60,676,014
July	4	17-37	70-30	33,569	7.94	166.28	10,406,390	2,601,597	398	67,513,781	55,125,924
August .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
September .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
October .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
November .....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
December	12	21-09	253-45	176,307	11.58	162.36	54,655,170	4,554,597	387	59,448,824	52,375,602
Totals and averages.	21	18-18	384-15	254,698	11.05	163.40	78,956,380	3,759,828	395	62,165,171	53,851,987

Table Showing Work Done with Worthington High-Service Engine for each Month during the Year 1889.

MONTHS.	No. of days' pump- ing.	Av. No. of hours' pumping per day.	Number of hours' pumping per month.	Number of strokes made per month.	Av. No. of strokes made per minute.	Av. head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Av. quantity pumped per day, in U. S. gallons.	No. gals. wa- ter pumped into reser- voir per lb. of total coal consumed.	Coal, in lbs., used when pumping.
January.....	5	16-11	80-55	173,913	35.82	78.67	2,434,782	486,956	319	7,640
February.....	4	14-56	59-45	132,061	36.84	78.67	1,848,854	462,213	319	5,800
March.....	4	14-34	58-15	126,920	36.31	78.67	1,776,880	444,220	320	5,550
April.....	5	11-34	57-50	120,920	34.85	78.67	1,692,880	338,576	300	5,640
May.....	5	16-52	84-20	170,695	33.73	78.67	2,389,730	477,946	321	7,440
June.....	4	13-49	55-15	116,453	35.13	78.67	1,630,342	407,585	326	5,000
July.....	4	17-30	70-00	145,909	34.74	78.67	2,042,726	510,681	300	6,800
August.....	5	15-28	77-20	160,199	34.53	78.67	2,242,786	448,557	301	7,440
September.....	4	13-49	55-15	121,349	36.61	78.67	1,698,886	424,721	300	5,660
October.....	5	10-20	51-40	124,370	40.12	78.67	1,741,180	348,236	304	5,730
November.....	4	10-00	40-00	83,066	34.61	78.67	1,162,924	290,731	319	3,640
December.....	4	13-42	54-50	120,025	36.48	78.67	1,680,350	420,087	311	5,400
Totals and averages..	53	14-04	745-25	1,595,880	35.68	78.67	22,342,320	421,553	311	71,740

<i>Amount brought forward</i>	\$647 79
7.75 pounds cotton waste, @ 11½ cents.....	91
2.05 pounds Eureka packing, @ 60 cents.....	1 23
12½ pounds hemp packing, @ 25 cents.....	3 19
Repairs on engine.....	2 36
Repairs on boilers.....	70
Recording gauge (proportional cost).....	3 50
Tools and stock.....	2 23
Sundries	1 12
Total	\$663 03

Cost of pumping water into reservoir per million gallons, \$8 40
 Cost of pumping water one foot high per million gallons, 05, ¹⁴/₁₀₀

The following table shows the average depth of water, the number of gallons, and the temperature of the water in the Beacon-street reservoir, and also the temperature of the air, for each month in 1889. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 P. M., and 6 P. M.

MONTHS.	Depth in Feet.	Quantity, in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air.
January.....	19.50	29,673,275	37.54	31.93
February.....	18.96	28,761,955	36.50	23.51
March	19.44	29,578,108	38.31	37.45
April	19.12	29,037,654	49.16	50.14
May	19.01	28,845,430	62.83	65.62
June	19.19	29,158,966	69.08	72.71
July	18.59	28,148,478	72.98	73.59
August	19.09	28,977,718	70.38	70.06
September.....	19.00	28,825,944	66.84	65.79
October	19.22	29,202,219	50.45	48.68
November.....	19.04	28,905,305	43.26	44.42
December	19.04	28,899,736	34.80	35.19

REPORT ON FILTRATION.

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REPORT ON FILTRATION.

BY J. ARTHUR GAGE, A. M., M. D.

To Lowell Water Board :

Gentlemen,—In discussing filtration, it may be well to look first at that which we wish to remove, and why we attempt to remove it, in order that we may more accurately estimate the value of any methods that might be employed. The impurities in water consist, first, of chemical impurities ; secondly, of living organisms (including Algæ, and the so-called “Germs,” or “Bacteria”). The first class was discussed in last year’s report ; its presence in Merrimack-river water noted, and the necessity of its removal urged. The Algæ are mostly found in ponds and need not be discussed here. The “Germs” deserve further mention. For our purpose, they may be divided into two general classes, the Saprophytic (non-disease-producing), and the Pathogenic (disease-producing). The first class comprises most of the germs found in water, and they are called non-disease-producing because they do not produce a *definite* disease in the human system. Nevertheless, they are believed to be injurious and capable of causing diarrhœal and other disturbances of the digestive tract, when taken into the system. This class includes a great variety of species and kinds, about which little is yet known, except that they occur in varying frequency in different waters, and that water containing them is proportionately unfit for drinking purposes. The frequency with which they occur may be estimated from the following figures. In spring water at its source, few or none are found, when the

1 c.c. of water. The Typhoid Bacillus is grown in a similar manner on *S* potatoes, and can be colored and detected by its shape, size, and appearance.

In selecting a water for drinking purposes, it is desirable to procure one where there is no contamination by chemical or living impurities. But where these are present, it becomes an important question how to get rid of them. This has been recognized in commercial circles, and householders have been urged to buy a variety of tap-filters, warranted to purify (?) the water. Recent experiments (Swarts), go to show the contrary. Seven different sink (or tap) filters were used, and the water flowing through these compared with the water from an open tap. For a few days, the filters removed some of the germs; but after seventeen days, all showed an increase of the number of germs, although some of the filters were claimed to be self-purifying by washing out. The original water supply contained thirty-six colonies of germs to one c.c. of water, while that of the filters varied from 2000 to 6000, the highest having 171,000. The filters simply caught the germs (and chemical poisons on which they feed), and allowed them to develop in the warm atmosphere of the room, only to be washed through later by the water and drunk by the individual. Filtration by this method, therefore, is positively dangerous and should be abandoned.

The subject of filtration is being studied by the State Board of Health, and though the results are not complete, they furnish an indication of the solution of the problem. As a result of the State authorities' experiments at Lawrence, Mass., the State Board finds that at the rate of 300,000 gallons of water to one acre of land (filter-bed 5 1-2 feet deep), about three-fourths of the ammonias are removed, nearly all the Algæ, and three-quarters of the Bacteria. The filtration was intermittent, and the temperature and length of time in use modified the result. After some months the impurities stored in the filter were washed through.

The color of the water was also much improved. When applying larger quantities of water, the results were not so good.

It is also difficult to see how the germs caught in the filter-bed can be washed out again, when the water, *under the same pressure*, is merely forced in the opposite direction; and it is possible that such a filter might, like the sink filters, only on a larger scale, retain the germs and allow them to increase, to further contaminate the water, unless the filter-bed was frequently replaced by fresh sand.

I must conclude, therefore, that the *mechanical filters* so far examined do not furnish a reasonable expectation of satisfactorily doing the work.

I remain respectfully,

J. ARTHUR GAGE.

Lowell, Mass., Jan. 2, 1890.

APPENDIX.

ANALYSES OF WATER.

[Published from advanced sheets of Annual Report of Massachusetts State Board of Health, through courtesy of Henry P. Walcott, M. D., Chairman.]

Chemical Examination of Water from the Merrimack River above Lowell, opposite the Inlet to the Lowell Water Works.

[Parts per 100,000.]

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATION.			AMMONIA.		Chlorine.	NITRO-GEN AS	
	Collection.	Examina- tion.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albumi- noid.		Nitrates.	Nitrites.
	18 87												
108	June 14	June 15	Slight.	Very slight.	0.40	3.90	1.55	2.35	.0020	.0122	.16	.0130	.....
332	July 14	July 15	Very slight.	Slight.	0.40	3.55	1.15	2.40	.0010	.0133	.12	.0030	.....
576	Aug. 18	Aug. 19	Very slight.	Very slight.	0.00	4.07	1.15	2.92	.0027	.0177	.14	.0070	.....
782	Sept. 15	Sept. 16	Slight.	Slight.	0.15	3.95	0.80	3.15	.0018	.0148	.20	.0070	.....
908	Oct. 20	Oct. 21	Very slight.	Very slight.	0.40	3.85	0.70	3.15	.0042	.0152	.19	.0080	.....
1209	Nov. 17	Nov. 18	Decided.	Con., earthy and flocc't.	0.75	5.15	1.25	3.90	.0028	.0203	.24	.0090	.....
1415	Dec. 15	Dec. 16	Decided.	Considera- ble, earthy	0.40	5.60	1.50	4.10	.0007	.0169	.15	.0120	.....
	18 88												
1644	Jan. 19	Jan. 21	Very slight.	Very slight.	0.30	3.95	1.00	2.95	.0016	.0116	.13	.0200	.0001
1848	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.90	0.95	2.95	.0046	.0150	.19	.0180	.0000
2020	Mar. 15	Mar. 16	Slight.	Very slight.	0.20	3.65	0.90	2.75	.0031	.0122	.21	.0080	.0002
2263	Apr. 19	Apr. 20	Distinct.	Con., earthy and flocc't.	0.25	6.30 2.65	0.70 0.65	5.60 2.00	.0000	.0116	.16	.0100	.0003
2450	May 17	May 18	Decided.	Much, earthy.	0.25	13.15 2.70	1.10 1.10	12.05 1.60	.0000	.0154 .0110	.09	.0030	.0001
2603	June 14	June 15	Very slight.	Slight, earthy and flocc't.	0.35	3.55	0.95	2.60	.0020	.0162 .0128	.16	.0100	.0003
2809	July 19	July 23	Very slight.	Very slight.	0.10	3.20	0.55	2.65	.0014	.0142 .0124	.19	.0050	.0001
2958	Aug. 16	Aug. 17	Slight.	Slight.	0.20	3.95	0.85	3.10	.0026	.0140 .0124	.22	.0070	.0002
2959	Aug. 16	Aug. 17	Slight.	Slight.	0.25	3.75	0.90	2.85	.0022	.0158 .0144	.22	.0080	.0003
2960	Aug. 16	Aug. 17	Slight.	Slight.	0.15	3.90	0.65	3.25	.0018	.0180 .0150	.22	.0070	.0002
3228	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.20	3.60	1.05	2.55	.0026	.0186 .0172	.16	.0080	.0005
3229	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.30	3.55	1.35	2.20	.0028	.0174 .0158	.15	.0030	.0004
3297	Oct. 18	Oct. 19	Slight.	Slight.	0.50	3.35	1.25	2.10	.0004	.0164 .0134	.11	.0070	.0002
3298	Oct. 18	Oct. 19	Slight.	Slight.	0.50	3.50	1.25	2.25	.0000	.0176 .0148	.13	.0080	.0003

Microscopical Examination.

	1888.	1889.
...

Groups and principal genera of organisms observed: 1. Cyanophyceae; 2. Palmellaceae, *Chlorococcus*; Zoosporeae, *Scenedesmus*; Desmidiaceae; Diatomaceae, *Synedra*, *Tubellaria*; 3. Schizomycetes; 4. Protozoa; Rotifera.

**Chemical Examination of Water from the Merrimack River above Lowell
at the Inlet to the Lowell Water Works.**

[Parts per 100,000.]

Hardness in May, 1938, 0.6. Odor, very faintly vegetable, often none, occasionally mouldy. The samples were collected in the inlet chamber where water comes in direct from the river and before it mingles with water from the filter-gallery or filter-inlet.

Examination of Water from Conduit (continued).

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy. The samples were collected from the conduit at the Bodwell gate-house. These samples are river water mixed with the water which comes from the filter-gallery, and show the quality of the water before it is pumped to the distributing reservoirs. The filter-inlet was cleaned July 14, 1888. The filter-gallery was cleaned soon after May 17, 1888.

Microscopical Examination.

	1888.						1889.				
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algae.....	0.1	0.0	0.0	0.0	0.0	.....	0.0	0.0	0.0	pr.	0.0
2. Other Algae.....	2.5	1.3	0.7	0.4	0.2	.....	1.7	0.4	0.8	1.5	0.8
3. Fungi.....	0.4	0.3	0.0	0.0	0.0	.....	0.0	0.0	0.0	0.0	0.0
4. Animal Forms.....	pr.	pr.	pr.	0.0	0.0	.....	0.1	0.0	pr.	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra*. 3. Schizomycetes. 4. Protozoa.

Microscopical Examination.

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Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa; Spongiaria; Entomostraca.

